Power Generation
and POWER PLANT ENGINEERING

For ALL Power Engineers • Steam, Electricity and All Other Power Engineering Services

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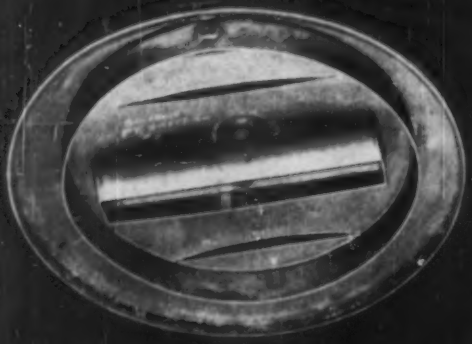
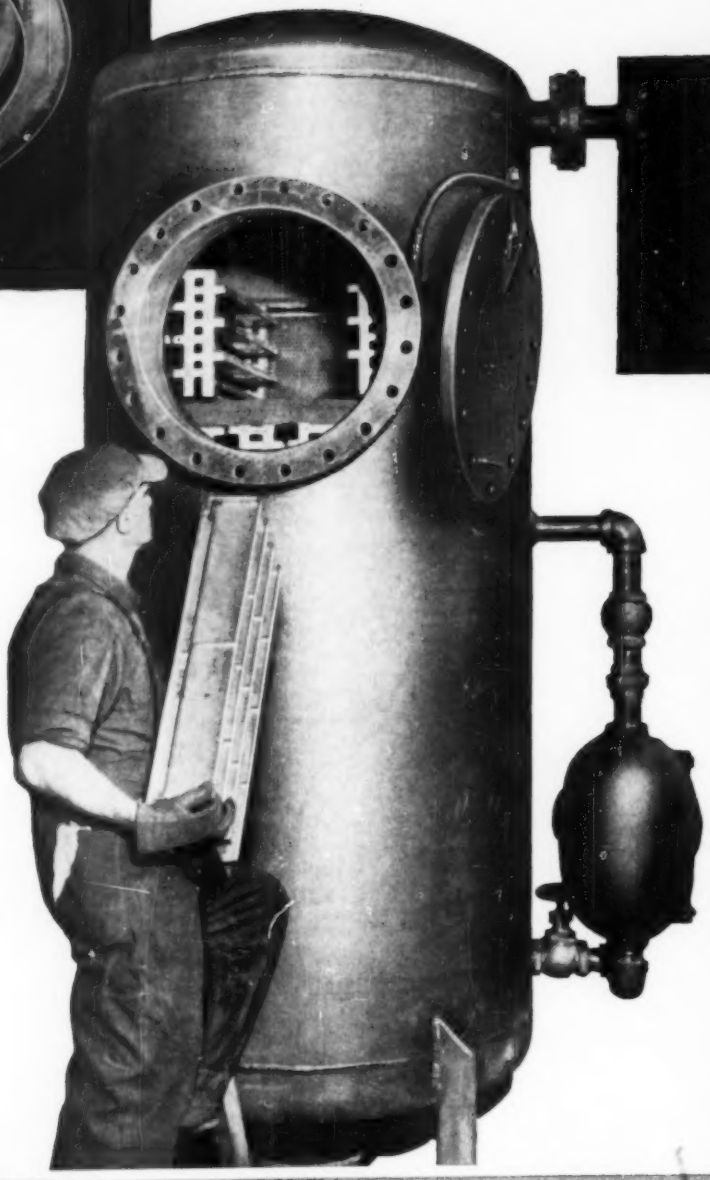
JANUARY
1950

This new



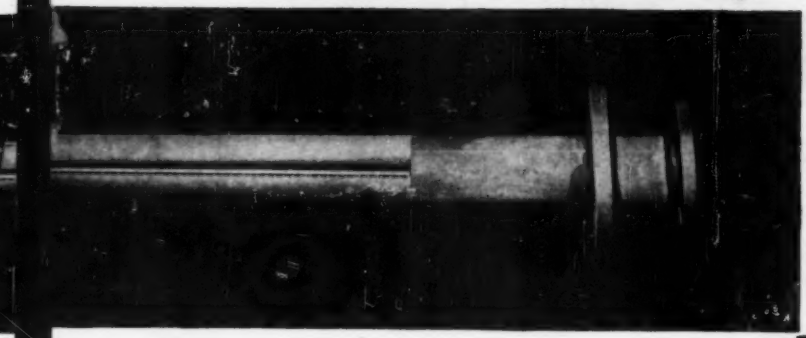


The deaerating heater head before welding in place. Showing the permanently located inner head, vent collecting hood and baffles. All this inner construction is of stainless steel.

ELLIOTT

TRAY-TYPE

DEAERATING HEATER
is completely self-contained

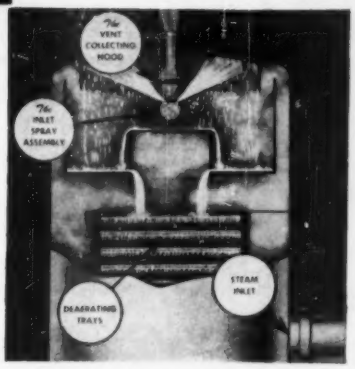


The inlet spray assembly, which with the vent collecting hood displaces the tubular vent condenser formerly used, with its many small tubes and constant maintenance problem. The inlet spray assembly can be readily pulled out if desired, although there is nothing about it to require replacement or readjustment.

NO TUBULAR VENT CONDENSER IS NEEDED with the new Elliott tray-type deaerating heater. This factor together with the use of stainless steel for all parts exposed to corrosive gases, eliminates practically all maintenance. However, should occasional inspection be desired, the inlet spray assembly may be readily withdrawn.

The trays too, are easy of access through the amply large inspection opening, the door of which is hung on a davit to be swung aside when the bolts are removed, and as readily replaced. Being of stainless steel the trays are comparatively light and easily handled. Trays, inlet spray assembly, and access opening cover are the only removable parts in the unit, all baffles, nozzles, etc. being permanently welded to the shell, as no maintenance or adjustment is required.

In this new deaerating heater Elliott again successfully breaks the trail toward more economical and dependable deaeration. Bulletin N-16—on request—gives the details.



Illustrating the operation of the Elliott tray-type deaerating heater. Water entering through the inlet spray assembly is sprayed across the opening of the vent collecting hood into the heating compartment, falls to the bottom of the heating section and down to the trays. By this time it has become heated to close to steam temperature. Falling from tray to tray it is constantly agitated and releases its non-condensable gases, which are carried upward by the incoming steam and ultimately through the vent collecting hood out the vent opening.

ELLIOTT COMPANY Deaerator & Heater Dept.
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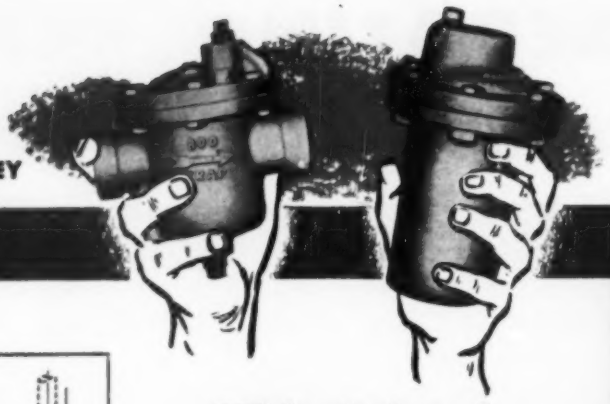
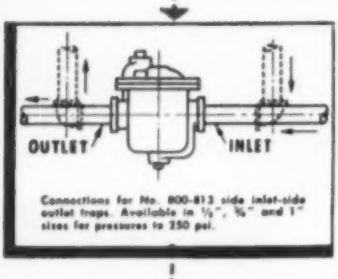
N-996

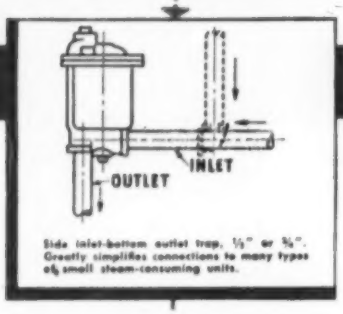
DEAERATING HEATER

YOU SAVE
TIME AND MONEY

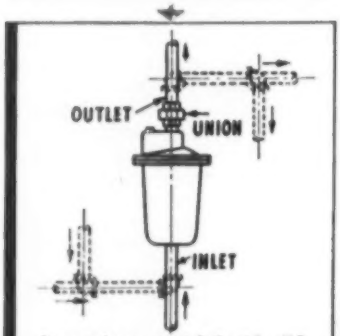




Connections for No. 800-813 side inlet-side outlet traps. Available in ½", ¾" and 1" sizes for pressures to 250 psi.



Side inlet-bottom outlet trap, ½" or ¾". Greatly simplifies connections to many types of small steam-consuming units.



Bottom inlet-top outlet body style, ½" through 2" connections. Cast semi-steel bodies for pressures to 250 psi. Forged steel bodies for pressures to 1500 psi.

"This choice of Steam Trap Body Styles simplifies installations"

IN THE most widely used sizes, Armstrong Steam Traps are available in either side inlet-side outlet or bottom inlet-top outlet body styles. This gives the user an opportunity to make exceptionally neat installations with a minimum of fittings and a minimum of labor and permits correct location of the trap in relation to the unit being drained.

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Contents of back issues of Power Plant Engineering and Power Generation will be found in both the Industrial Arts Index and the Engineering Index on file in Public Libraries.

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Power Generation

January 1950

VOLUME 54—NUMBER 1

Notes on This Issue

Special Review and Forecast Section

Every January the editors analyze developments in the field of power engineering and interpret trends for future progress. In this year, the midway mark of a century, the review and forecast is especially interesting to many people. Each year we receive many requests for extra copies of the section and last year one large company ordered 2500 reprints. Power engineers find the material valuable in planning their own plant development and manufacturers use it in market analysis. We won't attempt to outline the contents here. We are sure you will find this 16 page section not only of immediate interest but will want to keep it for future reference.

Practical Hints and Kinks

This page is largely devoted to discussion of feature articles but occasionally we like to call attention to the many specific, practical items which are so popular with readers in both big and small plants because they deal with every day problems.

Included under this heading in this issue are four articles as follows:

1. Faulty boiler hook-up. By A. H. Moulton. Mr. Moulton directs attention to a common malpractice, i.e., the use of a non-return valve on the main steam line of a boiler in combination with a direct condensate return system using a check valve. Either one of these arrangements is good but when the two are used together they constitute a hazard.

2. Anti-plug circuit eliminates commutator trouble. By Dean Huidston. This article describes a circuit involving a timing element which prevents careless or ignorant operators from "plugging" motors, that is from reversing the connections before the motor has come to rest in one direction.

3. The Hook-on Ammeter. By George Aiken. This is a very informative description of all the various things an operator can do with the Hook-on Ammeter. Any operator can learn a great deal from this very comprehensive description of how one operator uses this instrument.

4. Care and Operation of Outside Oil Storage Tanks. By W. F. Lorge. A description of the design and construction of a simple but very practical steam heater for oil storage tanks. This heater is installed inside the oil tank, yet can be taken out for repair or overhaul without emptying the tank.

New European Refinery Power Plant Designed for Dependability

Several interesting plants have been built in Europe during the recent past by American firms and engineers and American power engineers like to study the methods and equipment which are selected from American practices. In this issue we give you an excellent description of the power plant built for Caltex oil refinery (a European subsidiary of California Texas Oil Co.) at Rotterdam, Holland. The plant is built entirely of American equipment and shows what is happening in post-war European industrial activity. It is modern in every respect, operating at 550 lb pressure with 750 degrees F temperature. While most American engineers are not bothered with dykes it is interesting to see how they avoided breaching a dyke by building two 48 in. siphons to take water from the Maas River to the circulating water system.

The Thermoelectric Generator

Since the article by Curtiss D. Bassett in the August issue, many letters have come in from readers which show that they are wide-awake people with a very real professional interest in power developments. Maria Telkes, for example, who is Research Associate at MIT, told us about the work at MIT on this subject.

Mr. Bassett has suspected that heat transmission through the thermocouple might be a practical obstacle. Howard Podell of New York has made some interesting suggestions for an alternating current thermoelectric generator which might mitigate the seriousness of the heat transfer problems.

In this January issue we present results of further investigations by Mr. Bassett combined with Mr. Podell's ideas and a short preliminary explanation by Editor Kramer.

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DESCRIPTION	STAND. AND WEIGHT	EXTRA STRONG	SCHED. 160	DOUBLE EXTRA STRONG	LIGHT GAUGE NOMINAL PIPE SIZE	LIGHT GAUGE PIPE SIZE
ELBOWS—90° Long Radius	⅛"-24"	⅛"-24"	1"-12"	⅛"-8"	4"-24"	⅛"-12"
ELBOWS—90° Short Radius	1"-30"	1½"-30"				
ELBOWS—45° Long Radius	⅛"-30"	⅛"-30"	1"-12"	⅛"-8"	4"-24"	⅛"-12"
RETURNS—180° Long Radius	⅛"-24"	⅛"-24"	1"-12"	1"-8"	4"-24"	⅛"-12"
RETURNS—180° Short Radius	1"-30"	1½"-30"				
RETURNS—180° Extra Long Radius	1"-1½"	1"-1½"				
TEES—Straight	⅛"-24"	⅛"-24"	⅛"-12"	⅛"-8"		
TEES—Reducing Outlet	⅛"-24"	⅛"-24"	⅛"-12"	⅛"-8"		
REDUCERS—Concentric and Eccentric	¼"×⅛" thru 24"×20"	¼"×⅛" thru 24"×20"	¼"×⅛" thru 12"×10"	¾"×½" thru 8"×6"		
CAPS	⅛"-24"	⅛"-24"	1"-12"	1"-8"		
PIPE ENDS—Lap Joint	⅛"-24"	⅛"-24"				
NIPPLES	1"-24"*					
LATERALS—Straight	1"-24"	1"-24"				
LATERALS—Reducing on run	1"-24"	1"-24"				
CROSSES—Straight and Reducing	⅛"-24"	⅛"-24"				
RINGS—Welding, Union Type	⅛"-24"	1"-24"		1½"-8"		
RINGS—Welding, Ridge Type	⅛"-12"	⅛"-12"				
SLEEVES—Welding	2"-24"*					

* Since saddles and sleeves are for external reinforcement only, they do not conform to iron pipe size thicknesses.

TUBE-TURN FORGED STEEL FLANGES — RANGE OF SIZES

DESCRIPTION	150 LB.	300 LB.	400 LB.	600 LB.	900 LB.	1500 LB.	2500 LB.
WELDING NECK	½"-24"	½"-24"	½"-24"*	½"-24"	½"-24"	½"-24"	½"-12"
SLIP-ON	½"-24"	½"-24"	½"-24"*	½"-24"	½"-24"*	½"-24"	½"-12"
LAP JOINT	½"-24"	½"-24"	½"-24"*	½"-24"	½"-24"*	½"-24"	½"-12"
THREADED	½"-24"	½"-24"	½"-24"*	½"-24"	½"-24"*	½"-12"	½"-12"
BLIND	½"-24"	½"-24"	½"-24"*	½"-24"	½"-24"*	½"-24"	½"-12"
SOCKET TYPE	½"-24"	½"-8"	½"-2½"*	½"-2½"			
REDUCING—Threaded or Slip On	½"-24"	½"-24"	½"-24"*	½"-24"	½"-24"*	½"-12"	½"-12"
ORIFICE—Threaded		1"-24"	4"-12"	4"-12"	2"-12"	2"-12"	
ORIFICE—Slip On		1"-24"					
ORIFICE—Welding Neck		1"-24"	4"-12"	2"-12"	2"-12"	2"-12"	

* Dimensions on sizes thru 2½" same as for 600 lb. flanges.
* Dimensions on sizes thru 2½" same as for 1500 lb. flanges.

In addition to carbon steel welding fittings and flanges listed here, the complete Tube-Turn line embraces many other metals and alloys—types 304, 347, and 316 stainless steel, carbon moly and chrome moly steels, copper, aluminum, brass, Monel Metal, Inconel, nickel, wrought iron. Ask your Tube-Turn distributor for catalogs and other reference material.

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ENGINEERS' PREVIEW

ORAL AND WRITTEN TESTS for engineers are approaching the goal of positive identification of engineering ability. Proof of the relation between oral and written tests and the characteristics of a successful engineer was presented to the Engineers' Council for Professional Development, at their 17th Annual Convention, by E. C. Koerper of the A. O. Smith Corp.

Koerper's studies were made as chairman of the Milwaukee Plan of Personnel Development in Engineering. The committee followed two definite objectives, Koerper said: first, to develop effective means for assaying and specifying aptitudes, interests and personal qualities of individuals in engineering work; second, to develop a comprehensive job specification system for all engineering jobs.

The work was carried on under the Engineers' Society of Milwaukee, and the committee of the society spent three years working with the University of Wisconsin's Bureau of Industrial Psychology and cooperating industries, in creating the plan.

Firms that cooperated are: Harnischfeger Corp., the Falk Corp., Cutler-Hammer, Inc., the Allis-Chalmers Manufacturing Co., the Chain Belt Co., the A. O. Smith Corp., the Koehring Co., the Perfex Corp., and the Ladish Co.

★ ★ ★

AN AREA of 12 sq mi, bordering the Los Angeles-Long Beach harbor is sinking two inches every month, and since 1937 the subsidence has reached the astonishing total of more than nine feet. Removal of oil and gas from the Wilmington Oil Field is blamed for the subsidence. Since discovery of the field in 1932, about 2,000 wells have been drilled into the oil zone, which lies to a depth of from 3,500 to 7,000 ft. These wells are operated by 130 separate companies or individual owners, who are removing 45,000,000 barrels of oil annually and more than 64,000,000 cu ft of natural gas daily from the field. Engineers and geologists who have studied the phenomenon believe that the total subsidence will reach 18 to 23 ft by 1963 unless methods can be found to retard or stop it.

★ ★ ★

"IT IS THE INCLINATION of Americans to begin to build before the plans have cooled off, and to begin to plan before the basic facts are made known," Merrill Bernard, Chief Climatological and Hydrologic Engineer of the U. S. Weather Bureau said at the Fall Meeting of the ASCE. An exception to this traditional rule is the determination of federal agencies having an interest in the Nation's water control and utilization programs to pool their hydrologic needs and to coordinate their efforts to acquire the data on rainfall, stream flow, evaporation and snow cover, the speaker said. When acquired, these data are available to engineers in and out of government service.

"The hydraulic engineer's Utopia," Mr. Bernard told his audience, "is that in which he finds at every point of planned or potential river development a record of stream flow long enough to include the largest and smallest flows with enough observations to make the record trustworthy." Until such records are available, he said, the water planner must convert rainfall to equivalent runoff into rivers through adoption of assumptions which are becoming more dependable as time passes.

COLD WELDING by pressure alone, without use of heat or electricity, is a new method recently announced by William Dubilier, head of the Cornell-Dubilier Electric Corp. By use of simple hand tools with properly designed pressure points, a recent demonstration in New York showed that aluminum or copper in foil, wire and flat bar form could be fused and that similar tools could be used for nickel, silver and other relatively soft metals. At present the most important application of the process probably is in aluminum welding. One of the essential features of the method is clean surfaces, which will flow together under the right kind of deforming pressure and with tools of the proper shape. Neither heat, solder nor flux is required. The operation can be applied to aluminum sheath cable or BX wiring where the welded seam is made by a continuous rolling operation on a bent around strip. The process is being introduced in this country by Koldweld Corp. which has acquired American rights from the General Electric Co., Ltd., in England, where the process was first developed.

★ ★ ★

WILLIAM T. TAYLOR, author of the very original and practical armature winding diagrams, published in the October 1949 issue of POWER GENERATION (also previous diagrams published in 1943 and 1945 in *Power Plant Engineering*), sends us the following interesting comment from Natal, Union of South Africa, where he now lives.

"It would seem to me that you are not as yet aware of the cancellation of general U.S.A. exports to the Union of South Africa which came to an end during August last.

"What is of special importance right now to U.S.A. financiers, business men and industrialists who want to invest, expand their interests or acquire mineral deposits or lands in Southern and Eastern or South West Africa, is the opportunities offered. I can well assure you that the time is ripe for the American dollar to buy the most for the least, due to the devaluation and the opportunities made available because of import restrictions. This step is taken because Government desires its nationals (or foreign firms for that matter) to start or/and increase the local manufacture of goods.

"For several outstanding reasons, business men of the world have turned their eyes to various parts of this continent. Now is the time to acquire interests such as raw materials, mineral deposits, lands, concessions, and commence the building up of trade and manufacture to serve the East and Western countries.

"In various parts of the North and South American continents I have carried out business and technical investigations. At one time I was the Government Chief Electrical & Hydraulic Engineer, Kenya Colony, British East Africa.

"Right now there is a specially-appointed party of American experts surveying Kenya, Tanganyika, Nyasa and Portuguese East Africa, with a view to American capital entering those countries for developments. This continent now appears to offer the only SAFE financial outlets for the future."

Anyone interested may obtain further information on what Mr. Taylor has in mind through the ***Engineers' Preview*** Editor. He will forward any questions to Mr. Taylor, who will gladly answer them.

TINY, SUBMICROSCOPIC specks of silver iodide, which are capable of transforming supercooled clouds to snow, may be the key to any control man may eventually exercise over the weather, Dr. Vincent J. Schaefer, GE weather scientist, predicted recently. Silver iodide in its tiny particle form has proved more effective in producing snow than the materials nature uses. Man now can seed silver iodide through the atmosphere at much higher concentrations than nature distributes its snow-making materials.

Many cloud systems would be profoundly modified, rain would be produced in some instances and prevented in others, sunshine would be increased in some cases and lessened in others, and sudden, severe thunderstorms and hailstorms with resultant lightning would become rare.

★ ★ ★

LARGEST WIND TUNNEL at any university for research on problems of high-speed flight was dedicated December 1, 1949, at ceremonies marking completion of the Naval Supersonic Laboratory at the Massachusetts Institute of Technology.

Constructed under the auspices of the Navy Bureau of Ordnance, the wind tunnel was successfully operated at a speed twice that of sound. The tunnel is designed to provide speeds ranging from 1.2 to 4 times that of sound—up to 3000 mph.

The wind tunnel is a huge closed steel channel, through which very dry air is circulated by two large centrifugal compressors driven by electric motors of total capacity of 10,000 hp. The four-stage compressors have been especially adapted for this application to a supersonic wind tunnel.

The electric power required to operate the wind tunnel represents a large fraction of the generating capacity of the Cambridge Electric Light Co. Heat generated by the compressors is removed by two large coolers which use water from the nearby Charles River as the cooling medium. Approximately 3,000 gpm of water are needed to cool the various machines in the laboratory.

Air temperatures within the test section of the wind tunnel are quite low. At speeds twice that of sound, the temperature is 140 F below zero; at speeds four times that of sound, 335 F below zero.

Instrumentation for the wind tunnel includes a balance to measure the air reaction on the models and an optical system to show visually the shock waves and flow patterns that surround models in the supersonic air stream.

Jackson and Moreland, consulting engineers of Boston, had charge of the execution of the project.

★ ★ ★

ELECTRIC SHOCK frees gases in coal beds, says *Science Service*. Fuel gases from coal, as it lies underground in its natural seams, have been obtained by sending an electric current through the coal, the University of Missouri has announced. The accomplishment was made near Hume, Mo., on property of and with the cooperation of the Sinclair Coal Co.

Dr. J. D. Forrester, chairman of the university's mining department, said the process consists of drilling into a seam of coal. Iron pipes are inserted into the holes to serve as electrodes. Connected with the electrodes is a series of pipes a few feet above ground, through which the gas flows when it is generated. The gas can be used as raw material from which to make synthetic gasoline, or can be converted into a heating fuel.

IMPORTANT REVISIONS and enlargements in existing standards for graphical symbols in many fields have recently been completed by the ASME Committee on Standardization of Graphical Symbols, to meet the current requirements of industry. This work has had three phases: 1) Revising and enlarging existing standards for graphical symbols; 2) Simplifying and clarifying the symbols and their classification; and 3) Developing new symbols. Results have been incorporated in a number of standards covering: welding and instructions for use; plumbing; pipe fittings, valves and piping; heating, ventilating and air conditioning; railroad equipment and heat-power apparatus. The separate publications covering each of these fields sell for prices ranging from 40 cents to 75 cents per copy. Since these revisions in the language of graphical symbols provide engineers with an improved method of indication, you will doubtless want to obtain copies and make certain your practice is up to date. For further information about these write to E. M. Murrayes, Publication-Sales Department, The American Society of Mechanical Engineers, 29 W. 39th Street, New York 18, N. Y.

Adoption of new letter symbols for electrical quantities has been announced by the American Standards Association. A new edition of the American Standard Letter Symbols for Electrical Quantities is now available and copies of the publication, Z10.5-1949, are available from the American Standards Association, 70 East 45th Street, or from the American Institute of Electrical Engineers, 33 West 39th Street, New York, N. Y., at 60 cents per copy.

★ ★ ★

ORDERS FOR STEEL, flowing into the mills once more with the end of the strike, are being handled by a new, private telegraph switching center installed recently at Carnegie-Illinois Steel Corp. offices.

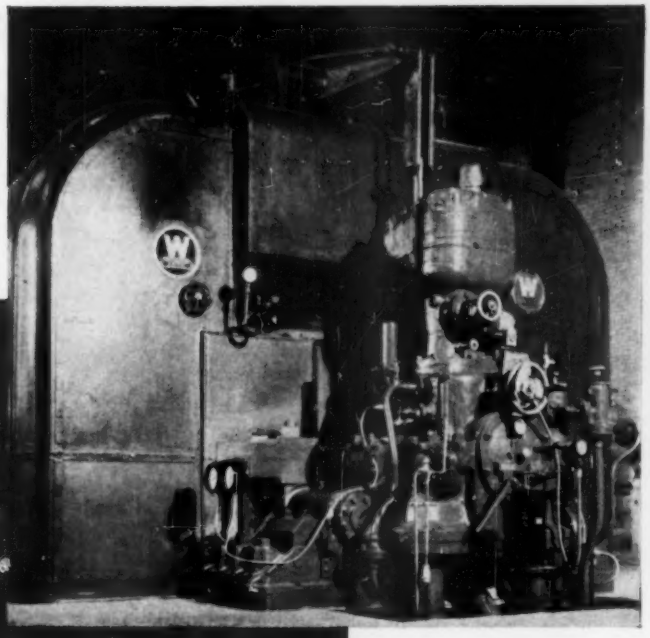
The new push-button system, replacing the old cord-and-plug type, is designed for speed and ease in switching the nearly 12,000 incoming messages received each day by the corporation's Chicago station for destination points all over the nation.

Through this system, any station in the network can transmit telegrams to any other by pushing a button and without any additional manual handling of the message at any point. Each message is typed only once on the typewriter-like keyboard of a teleprinter at the originating point, and flashes to the center. There a clerk sees the destination on a tape, touches the proper button, and an electric brain connects the message with a circuit to its destination.

High speed push-button switching, one of the latest developments in the rapid technical progress of the communications industry, is an achievement of research engineers of the Western Union Telegraph company.

★ ★ ★

NATION'S FIRST graduate school of industrial administration was opened on an experimental basis September 19 at Carnegie Institute of Technology. This is the school founded last winter by a $6,000,000 gift to Carnegie from the W. L. and May T. Mellon Foundation. Officially called the School of Industrial Administration, William Larimer Mellon, Founder, the new School opened with six specially selected students and seven professors, who will be assisted by other members of Carnegie's faculty. Dr. George Leland Bach, head of Carnegie's Economics Department, is Acting Dean of the new School.



GET 3-WAY PROTECTION

Lubricate with TEXACO REGAL OILS (R&O)

Your turbines get full protection against the dangers of (1) rust, (2) sludge, and (3) foam, when you use *Texaco Regal Oils (R & O)*. Only the choicest base stocks are used in making these world-famous oils. They are specially refined, fortified with rust and oxidation inhibitors, and processed to prevent foaming.

Texaco Regal Oils (R & O) thus keep turbine lubricating systems clean through extra years of service life. This means bearings are kept smooth and safe in a constant flow of cool, clean oil . . . governor response is always sensitive and swift.

Texaco Regal Oils (R & O) meet the exacting requirements of all leading turbine builders, and the turbine oil specifications of the United States Navy.

Get an extra margin of safety by using *Texaco Regal Oils (R & O)*. A Texaco Lubricating Engineer will gladly explain to you in detail. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, New York.

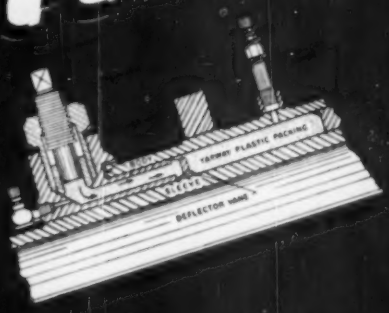
TEXACO

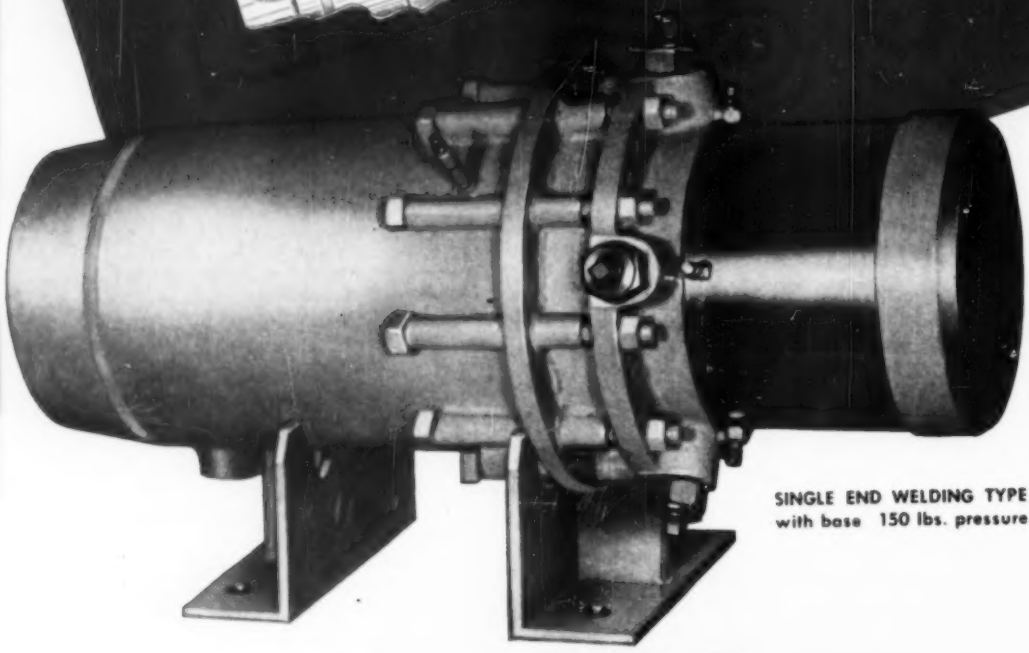
TEXACO Regal Oils (R&O)

FOR ALL TURBINES

TEXACO presents MILTON BERLE on television every Tuesday night. METROPOLITAN OPERA radio broadcasts every Saturday afternoon

SAVE LABOR WITH GUN-PAKT





SINGLE END WELDING TYPE
with base 150 lbs. pressure

YARWAY

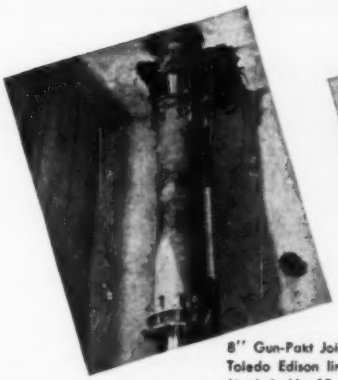
TOLEDO EDISON CHOOSES THE EXPANSION JOINT THAT IS *Serviced* UNDER FULL STEAM PRESSURE

Toledo Edison Company knows how to save on expansion joint maintenance. They use Yarway GUN-PAKT Joints—22 of them, ranging in size from 8" to 14" on their recent steam distribution extension.

GUN-PAKT Joints are serviced under full steam pressure . . . no costly shutdowns or heating interruptions. For repacking, simply insert a packing plug, twist a wrench, and the job's done! Special Alemite fittings provide for proper lubrication. Maintenance costs are low. One user says only 65 cents per year per joint. Others claim less than that. But wherever steam is distributed, and expansion joints are used, the trend is toward GUN-PAKT.

Read the GUN-PAKT story in Yarway's Bulletin EJ-1912. Write—

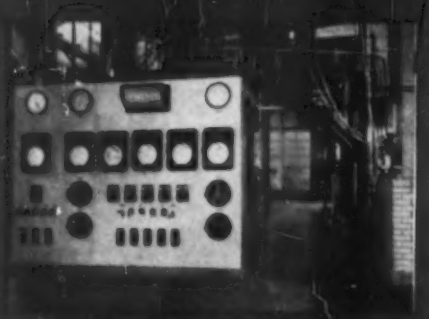
YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.

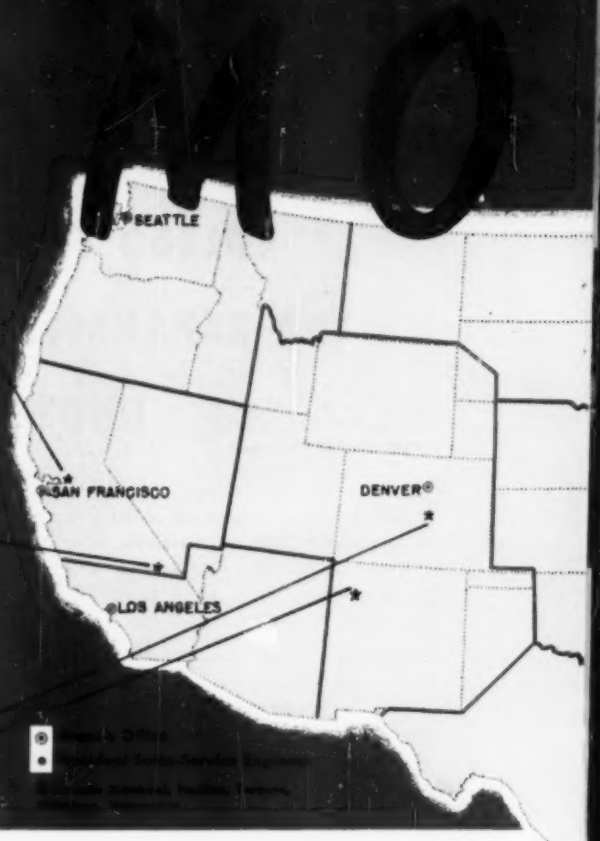


8" Gun-Pakt Joint on Toledo Edison line at Manhole No. 12.

Yarway Gun-Pakt Joint on Toledo Edison Jackson Avenue line.

14" Gun-Pakt Joint in Toledo Edison No. 1 Manhole.





More Power per fuel dollar—that's the basic business of Bailey Meter Company. Our products and services are designed to deliver increased power plant efficiency for you, whether your plant is large or small. We have had a wealth of experience on every size and type of steam generating equipment.

Here are some of the reasons why we believe we have more to offer you in this field than any other single manufacturer:

More Complete Range of Equipment

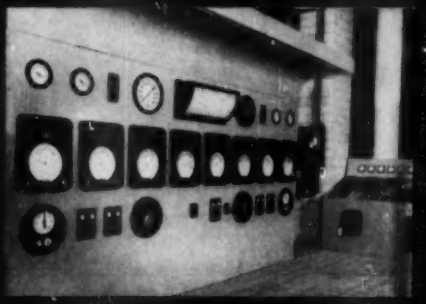
Our fully co-ordinated line of Meters and Controls is offered for a wide variety of services and in a complete range of types. This means you need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment merely because he is unable to offer the exact one best suited to your needs. It means, too, that you need never fear a buck-passing division of responsibility for the efficient operation of your complete boiler control system.

More Experienced Engineering Service

When you discuss your power plant problems with a Bailey Sales-Service

Give More Power to You...

Combustion • Feed Water • Temperature • Pressure • Liquid Level • Feed Pumps



Engineer, you get advice from an organization with a background of more knowledge and experience in steam plant operation than any other manufacturer of instruments and controls can offer you. Our field representatives are graduate engineers with specialized training in combustion, flow measurement and automatic control. Each has completed an intensive course in theory and practice at our plant before being given a field sales-service assignment.

More Direct Sales-Service Offices

Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems. Truly, prompt and capable service—and with a minimum of travel time and expense—is as near as your telephone. In emergencies a trained Bailey Engineer is available in a matter of minutes or a few hours at the most.

Giving More Power to You

Better power plant operation calls for more power per fuel dollar, less outage, and safer working conditions. We help you to get all of these. Write for Bulletin 15G describing Bailey Meters and Control Systems.

Bailey Meter Co.

C-E Vertical-Unit Boilers

Modern steam generating equipment can't lower the price of a ton of coal or a barrel of oil, but it *can* produce *more* steam from every ton of coal or every barrel of oil. The modern unit can't lower the cost of a man-hour, but it *can* and *does* operate so reliably that maintenance costs are kept at a minimum.

C-E Vertical-Unit Boilers represent truly modern standards of design. To an exceptional degree they incorporate all the important advances in steam generation made in the past twenty-five years . . . advances that have resulted in substantially increased efficiencies and lower operating costs. At today's high costs of fuel and labor, these gains in operating efficiency may well prove the difference that will make replacement a profitable procedure for you. So whether you are considering the purchase of equipment for replacement or expansion, or for a new plant, a C-E Vertical-Unit Boiler will provide the right answer to your particular situation.

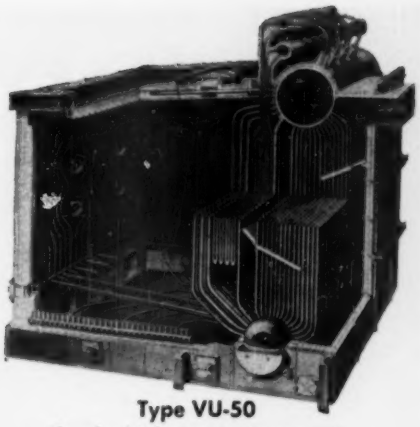
The three units illustrated – and others in the Vertical-Unit line not shown – are collectively designed to serve virtually every industrial requirement from about 10,000 to 300,000 (or more) lb of steam per hour, pressure up to 1,000 psi and steam temperatures to 900 F. The entire Vertical-Unit line offers the advantages of time-tested standards of design coupled with that flexibility of application – fuels, firing methods, operating conditions, etc. – required to meet particular plant needs. We shall be pleased to supply catalogs and any additional information required upon request. B-371

COMBUSTION ENGINEERING

A MERGER OF COMBUSTION ENGINEERING COMPANY, INC., AND THE SUPERHEATER COMPANY

-Unit

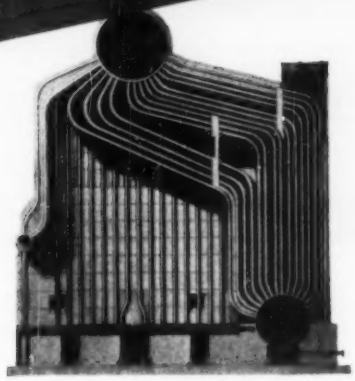
today's best answer to high steam costs



Type VU-50

(for the higher capacity range)

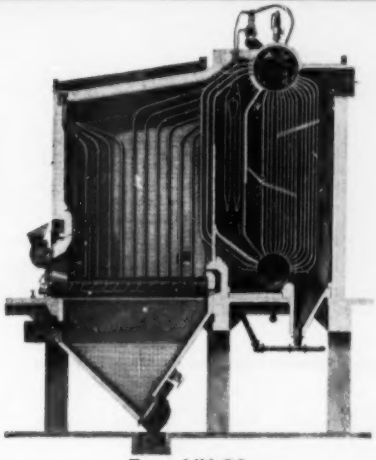
This unit, the original VU design, may be fired by pulverized coal, oil or gas, or any combination of these fuels. Available for capacities up to 300,000, or more, lb of steam per hr, pressures up to 1000 psi and steam temperatures up to 900 F, or higher. Furnace bottom may be as shown or may be of hopper type. Economizer or air heater surface may be added.



Type VU-10

(for the lower capacity range)

This member of the VU family is designed for industrial load conditions and particularly for plants having small operating and maintenance forces. Capacities range from about 10,000 to 50,000 lb per hr. Firing may be by spreader, underfeed or chain grate stokers, or by oil or gas burners. Any of these methods may be substituted for any other, should fuel market conditions make this desirable.



Type VU-30

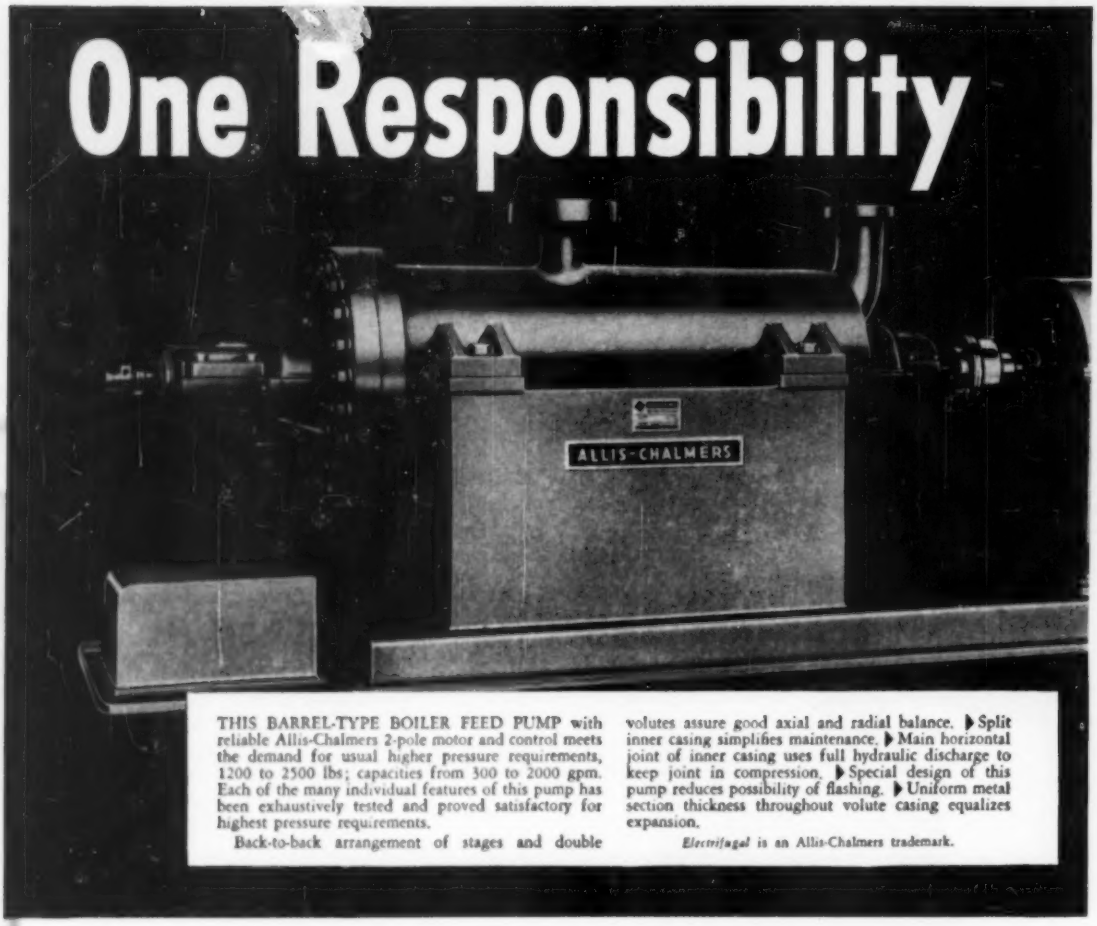
(for the middle capacity range)

In this VU design, shown equipped with a C-E Spreader Stoker, the furnace proportions and arrangement of water wall surfaces may be adapted for firing by any type of mechanical stoker. Design is also adaptable for firing by oil or gas. Economizer or air heater surface may be added. Approximate capacity range 25,000 to 100,000, or more, lb per hr.

—SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

One Responsibility



THIS BARREL-TYPE BOILER FEED PUMP with reliable Allis-Chalmers 2-pole motor and control meets the demand for usual higher pressure requirements, 1200 to 2500 lbs; capacities from 300 to 2000 gpm. Each of the many individual features of this pump has been exhaustively tested and proved satisfactory for highest pressure requirements.

Back-to-back arrangement of stages and double volutes assure good axial and radial balance. ▶ Split inner casing simplifies maintenance. ▶ Main horizontal joint of inner casing uses full hydraulic discharge to keep joint in compression. ▶ Special design of this pump reduces possibility of flashing. ▶ Uniform metal section thickness throughout volute casing equalizes expansion.

Electrifugal is an Allis-Chalmers trademark.

Choose from *Complete* Allis-Chalmers Power Plant Pump Line, Including Motors and Control, and Save Time . . . Improve Equipment Coordination . . . Center Responsibility

BECAUSE Allis-Chalmers builds not only a complete line of power plant pumps, from boiler feed service to ash-handling, but the matching motors and control as well, it is able to take on responsibility for an entire power plant pumping "package." You gain three ways:

First, by consolidating selection and ordering you save time on engineering, pencil-work, etc. Second, your drives can be closely matched to pump requirements for most economical power. And third, you eliminate buck-passing, *know exactly* where to place responsibility should *any* component fail.

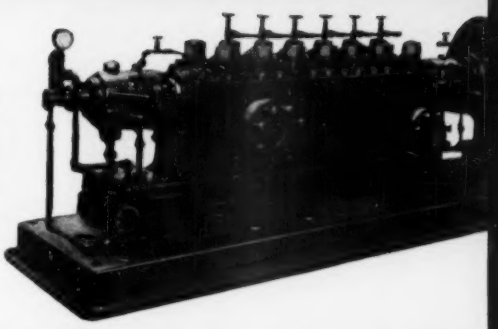
In the case of plants planning ahead, toward generation at the new, high steam conditions, this coordination is a "must."

For plants now operating obsolete or inefficient pumps it offers a quick, sensible solution to the problem of bringing operating costs in line with industry standards.

There is a qualified Allis-Chalmers representative nearby who will be glad to get down to cases with you. Meanwhile, mail coupon at right for advance information on pumps in which you are interested.

ALLIS-

for Pump Performance!



Double Suction, Split-Casing Boiler Feed — a multi-stage, high head design built in all standard sizes. Standard pumps include casings of nickel cast iron with bronze fittings, or alloy steels where required. Volute casing assures smooth operation over a wide range of head and capacity.

OTHER ALLIS-CHALMERS PUMPS FOR POWER PLANT SERVICE:

Circulating—sizes to 100,000 gpm with moderate heads. 3 types: vertical axial flow; vertical mixed flow; horizontal and vertical centrifugal, Type S.

Boiler Recirculating — built to specification for the particular installation. Type of pump and requirements set by type of boiler.

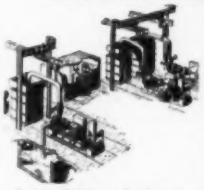
Condensate Removal — various types; horizontal and vertical designs.

Heater Drain—number of A-C pumps available in suitable types and sizes. Size of plant is determining factor.

Service, Wash Water, Evaporator Feed. For all cool, clear water applications A-C generally recommends Type S pumps.

Ash Handling—Type CW abrasive-resistant pumps recommended. 8 sizes, capacities to 10,000 gpm, heads through 140 ft.

NEW TEST FLOOR PROVIDES DATA ABOUT ALLIS-CHALMERS PUMPS



Motor speeds read to within less than one rpm. ▶ Water flow timed electronically, then weighed. ▶ The torque input to pump measured with electronic torsion meters. ▶ Possibility of "human error" removed. ▶ New floor aids in testing designs to build better pumps.

For many years A-C has maintained files of complete performance data on each pump built. Now, you are further assured of a completely mechanical precision check of pump performance.

A-2853

ALLIS-CHALMERS, 953A SO. 70 ST. MILWAUKEE, WIS.

Please send me information on your pumps for the following services:

_____

_____

_____

NAME _____

TITLE _____

FIRM _____

CITY _____ STATE _____

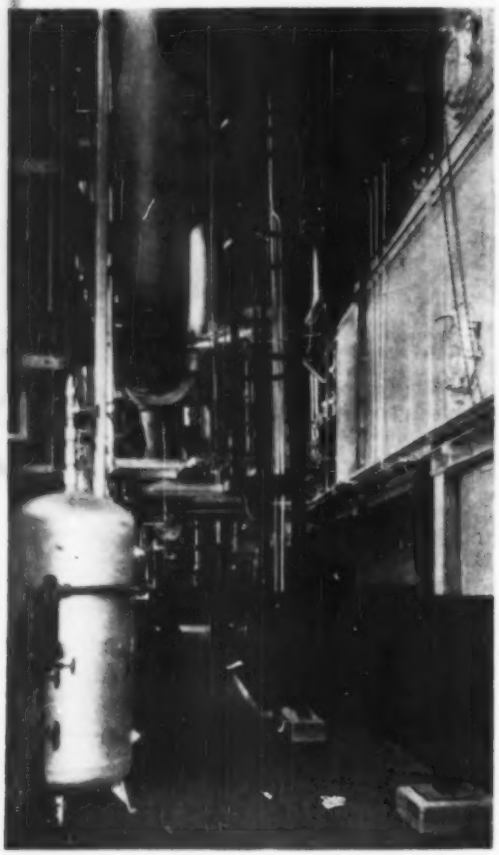
CHALMERS

A-C ALLIS-CHALMERS

Automatic Combustion Control... Ring Balance

. . . by HAGAN, *at the*

Recent expansion of the refinery of Gulf Refining Company at Cleves, near Cincinnati, included the installation of two new boilers, each with a capacity of 70,000 pounds of steam per hour, and operating at 685 psi. Fuels used are refinery waste gas and oil, either singly, or in combination.



These new boilers are equipped with Hagan Automatic Combustion Control, Hagan Automatic Feedwater Regulation, and Hagan Ring Balance Meters.

The combustion control is a Hagan Differential Master system. With this system, waste gas is burned when available and is automatically supplemented or replaced by oil as necessary. Fuel feed is changed instantly to compensate for fluctuations in calorific value of fuel or changes in steam demand and excess air is automatically maintained in accordance with actual Btu input.

Hagan Automatic Feedwater regulation is a multiple circuit system which proportions feed water to steam flow and modifies feedwater flow in accordance with water level in the boiler. Thus this system not only holds water level accurately in a steady steaming state, but also "irons out" in an optimum pattern, the mutual disturbances which exist between the steam generating circuits and the water flow circuits of the boiler in changing from one steam rate to another.

Two Hagan Ring Balance Meters are used with each boiler. One records steam flow, air flow and

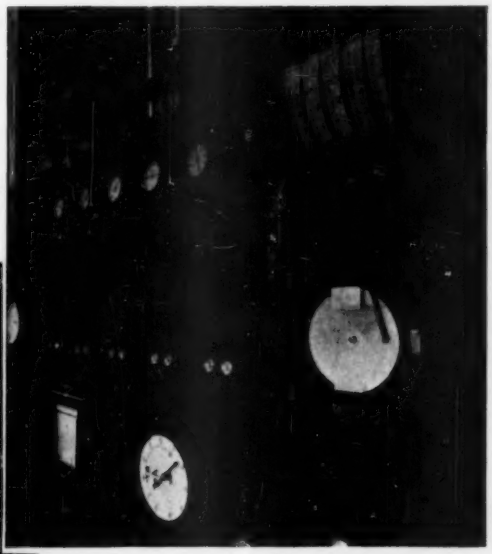
◀ *General view showing front of boilers and instrument panels in Gulf Refining Company refinery at Cleves, Ohio.*

Meters . . . Automatic Feedwater Regulation

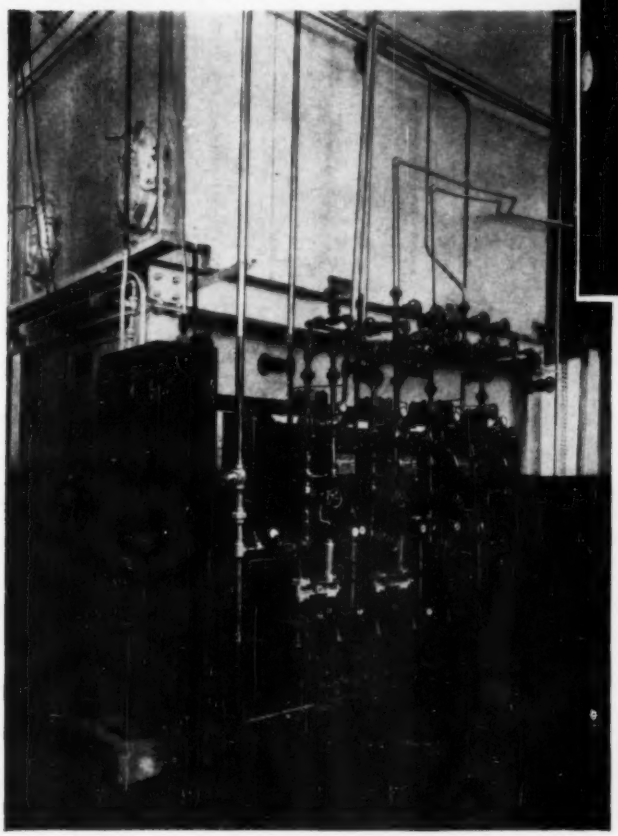
CLEVES, OHIO, REFINERY OF GULF REFINING COMPANY

steam pressure; the other records feedwater flow and steam drum water level.

We will be glad to supply full information on Hagan Combustion Control, Hagan Automatic Feedwater Regulation and Hagan Ring Balance Meters. Write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.



▲ *Separate instrument panels are provided for each boiler. Two Hagan Ring Balance Meters are mounted on each panel.*



◀ *Components of the Hagan automatic feedwater regulation and combustion control systems are mounted at the side of each boiler, giving easy access for adjustment or servicing.*

HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

WHEN LOAD FLUCTUATIONS

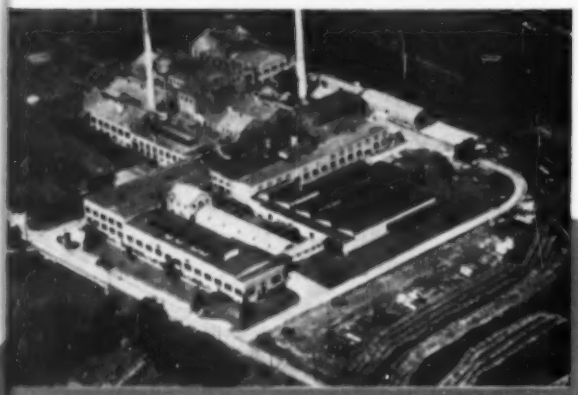
ARE SUDDEN AND VIOLENT...

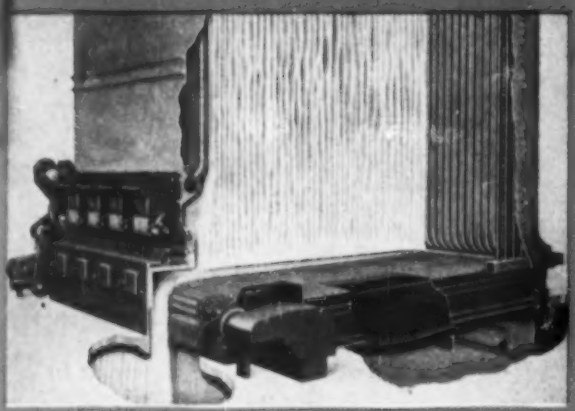
at THILMANY PULP & PAPER COMPANY

KAUKAUNA • • • WISCONSIN

This is typical Detroit RotoGrate performance. Steam loads on this unit vary in a few minutes from a rate of 30,000 pounds per hour to 120,000 pounds.

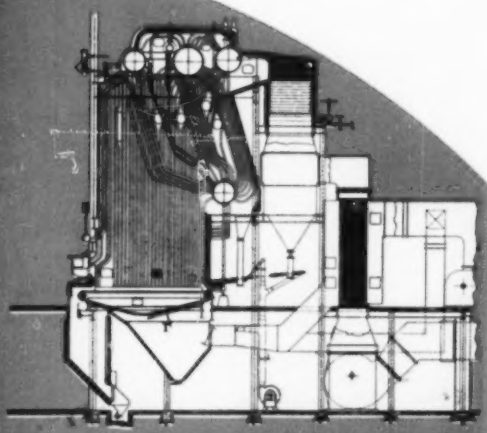
Practically uniform pressure is maintained—amazing flexibility.





Detroit RotoGrate Stoker with six grate sections as applied to a typical water cooled furnace of a steam generator. Two of the six rotors are removed to show the unique overlapping grate design.

The trend is toward RotoGrates which cut the cost of producing steam.



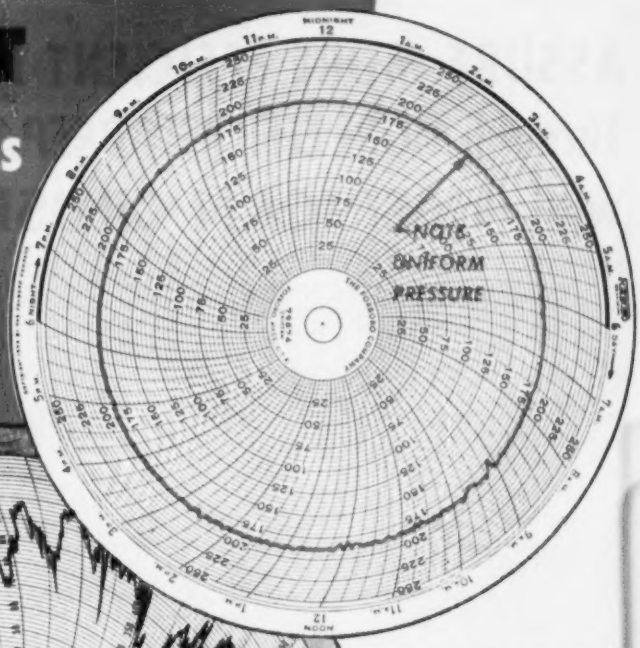
Detroit RotoGrate Stoker applied to a four drum unit having a water cooled furnace, air heater and economizer at Thilmany. Detroit RotoGrate is an advanced design of spreader stoker with forward moving grates that discharge the ash at the front.

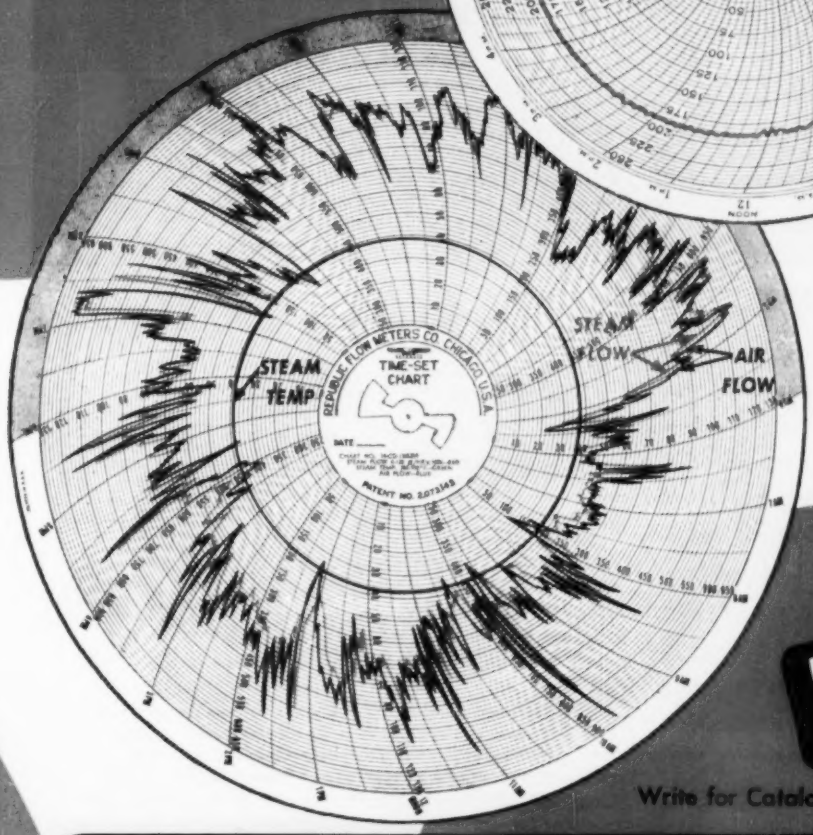
DETROIT

ROTOGRATE STOKERS

keep pressure

UNIFORM





Typical Steam Flow-Air Flow and Steam Temperature Charts under normal operation at Thilmany, show rapid load fluctuations from rates of 30,000 to 120,000 pounds with a sustained load of approximately 100,000 to 110,000 pounds per hour.

DETROIT SINCE 1906 STOKERS

Write for Catalog . . . No obligation.

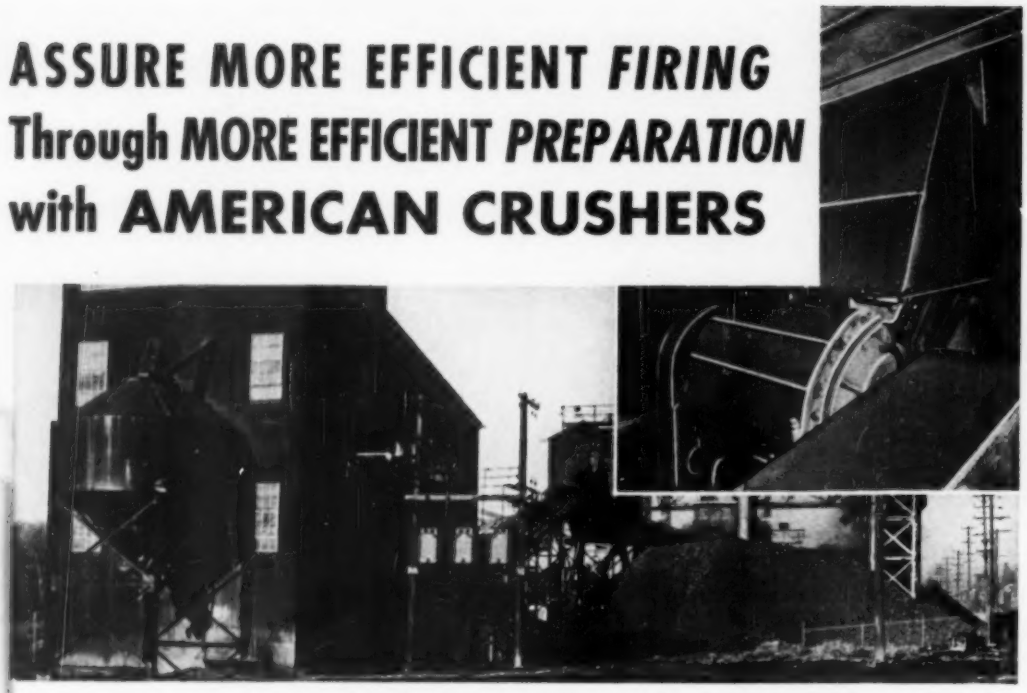
DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

Works at Monroe, Michigan . . . District Offices in Principal Cities

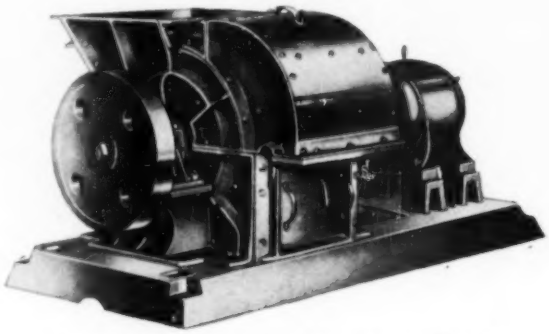
OTHER TYPES AND SIZES OF DETROIT STOKERS FOR EVERY INDUSTRIAL OR POWER NEED

ASSURE MORE EFFICIENT *FIRING* Through MORE EFFICIENT *PREPARATION* with AMERICAN CRUSHERS



Shown above is the preparation plant of the Windsor Power House Co., Power, W. Va., where the American Rolling Ring Crusher Model 42S (in insert) is in daily operation.

Quality of coal crushing is as important to combustion efficiency as the quality of coal itself—one reason why Americans are chosen by so many power plants to do the crushing job. The **splitting action** of Americans assures uniform sizing—no oversize—and fines are accurately controlled. The result: a dependable, constant yield of stoker or pulverizer size to assure a uniform, responsive firebed—for greater operating efficiency.



Designed especially for power plants, the American "S" Crusher is a compact, complete crushing operation which is installed in minimum headroom without extensive conversion—and with no auxiliary crushing facilities. Nine different sizes, with capacities from 25 to 500 TPH.

Write for bulletin on efficient coal preparation in power plants.

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1429 MACKLIND AVE.
ST. LOUIS 10, MO.

"We had a real Problem on our hands
. . . how to get maximum productive energy from our fuel without uselessly heating excess air."

"This remarkable Cities Service Heat Prover quickly solved our problem"

SCORES of large industrial plants have found this exclusive Cities Service Heat Prover Service a tremendous help in uncovering facts vital to efficient production such as:

1. How much energy is wasted in uselessly heating excess air?
2. How much excess oxygen is present in furnace gases?
3. What percentage of fuel is converted into productive energy?

The Cities Service Industrial Heat Prover answers these questions quickly and accurately. Moreover, the instrument has been developed for use on industrial furnaces of every design regardless of the type of fuel used.

Write today for a free demonstration. There is no charge, or obligation.

Free

A fact-filled booklet entitled "Combustion Control for Industry." Write Cities Service Oil Company, Sixty Wall Tower, Room 541, New York 5.

CITIES SERVICE

a tradition of leadership

On the evening of July 4th, 1883, Thomas A. Edison placed in operation the first three-wire central station electric lighting plant in the world at Sunbury, Pa. Power was supplied to the old City Hotel three blocks away which was then on the site now occupied by the Hotel Edison.

FUTURE EXPANSION

The world's largest power plant using pulverized anthracite has been completed recently on a site near Shamokin Dam along the Susquehanna River about two miles below Sunbury, Pa. This 150,000 kw installation, first of a number planned for the site, is part of the Pennsylvania Power & Light Company's network serving 28 counties which cover an area of 9,500 sq miles in central eastern Pennsylvania.

The two 75,000 kw turbine generators are served by four 130-ft high Foster Wheeler Steam Generators, the largest ever built for direct firing of pulverized anthracite.

An extension of 100,000 kw capacity, now under construction, will be completed in 1951 and equipped with Foster Wheeler Steam Generators.

FOSTER WHEELER CORPORATION · 165 BROADWAY

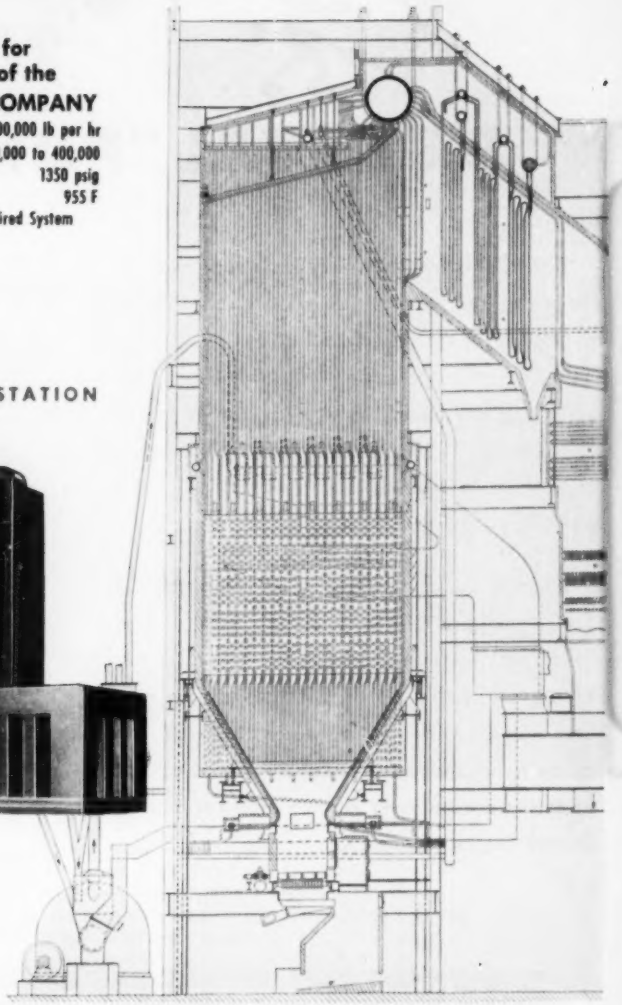
Four FOSTER WHEELER Units for Sunbury Steam Electric Station of the

PENNSYLVANIA POWER & LIGHT COMPANY

Capacity	400,000 lb per hr
Superheat Control Range	250,000 to 400,000
Pressure Superheater Outlet	1350 psig
Final steam Temperature	955 F

Anthracite Coal Pulverized in FW Ball Mills in Direct Fired System

NEW SUNBURY STEAM ELECTRIC STATION



Each steam generator is equipped with two Foster Wheeler ball mill pulverizers which have a combined output of 27 tons of coal per hr.

FOSTER WHEELER

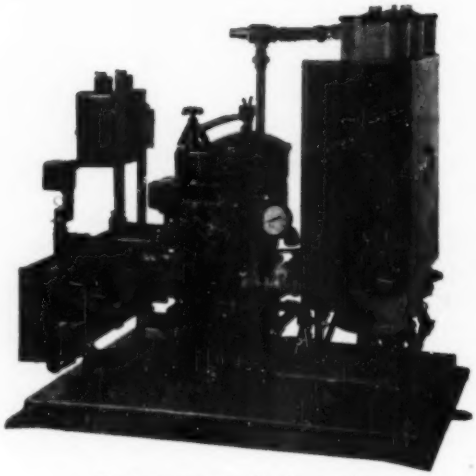
NEW YORK 6, N. Y.

GET RID OF ALL 3 TROUBLEMAKERS...

WITH THE DE LAVAL "PURI-FILTER"

The De Laval "Puri-Filter" removes all three major contaminants of Diesel lubricating oil: dirt, water and colloidal carbon. The first two are separated from the oil by centrifugal force in the bowl of the De Laval Oil Purifier—the water being discharged continuously. The colloidal carbon is filtered out of the purified oil by the filters.

The De Laval "Puri-Filter" combines the De Laval "Uni-Matic" Oil Purifier and Fram "Filcron" Filters. Because the combination unit gets rid of all contaminants down to one micron in size, and likewise keeps the oil completely free of moisture, it is the most effective means ever devised for protecting Diesel engine bearings.

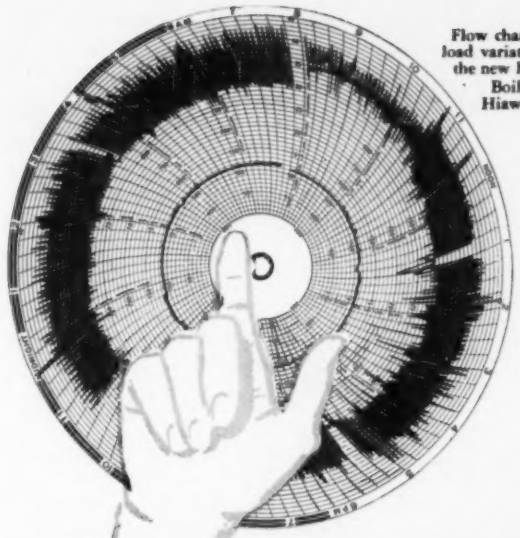


Crank cases remain clean when Diesel oil is "Puri-Filtered." Write for Bulletin DL-1, which gives additional details.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL *Oil Purifiers*

FOR DIESEL LUBRICATING OIL



Flow chart shows typical load variations for one of the new Integral Furnace Boilers, Type FF, at Hiawatha Gas Plant.

Two Integral-Furnace, Type FF, Boilers arranged to burn either bituminous coal or coke breeze, mixed, or 100% of either at full load, intermittently.

PUTTING THE INDIAN SIGN ON LOAD SWING

. . . with B&W Integral-Furnace Boilers at Hiawatha Gas Plant

Typical of how the B&W Integral-Furnace Boiler, Type FF, responds to quick-steaming and severe load-swing demands is the performance of two 35,000 lb. per hr. units at the Hiawatha gas-plant of the Central New York Power Corporation of Syracuse, N. Y. Each boiler successfully meets three-minute load variations of 8,000 to 12,000 pounds per hour instantaneously, up or down ... responds to the irregular quick-steaming demands characteristic of gas plant operation.

Ability to satisfy Hiawatha's unusual load and fuel requirements is just one of the many reasons why so many industrial and power companies consider B&W boilers the best buy for low-cost, dependable steam generation. Their industry-wide acceptance for power, heating, and process steam requirements is an 80-year-old story . . . yet one that is continually being revised to meet changing practices and needs. One chapter in this story which answers many steam supply problems is presented in a new bulletin of facts about the Integral-Furnace Boiler, Type FF. Ask for Bulletin G-64.

The Babcock & Wilcox Company, 85 Liberty St., New York 6, N. Y.

BABCOCK & WILCOX

QUESTION:

Which Garlock Gasket keeps joints tight regardless of temperature changes and vibration?

Cross-sectional view of the GUARDIAN gasket illustrates its unique and rugged construction—alternate layers of scientifically shaped strip metal and asbestos. Note the double thicknesses of metal on both the inner and outer edges.

When so ordered, GUARDIAN gaskets are supplied with metal *centering rings* for raised face pipe flanges and other applications.

ANSWER:

GARLOCK *Guardian GASKET**

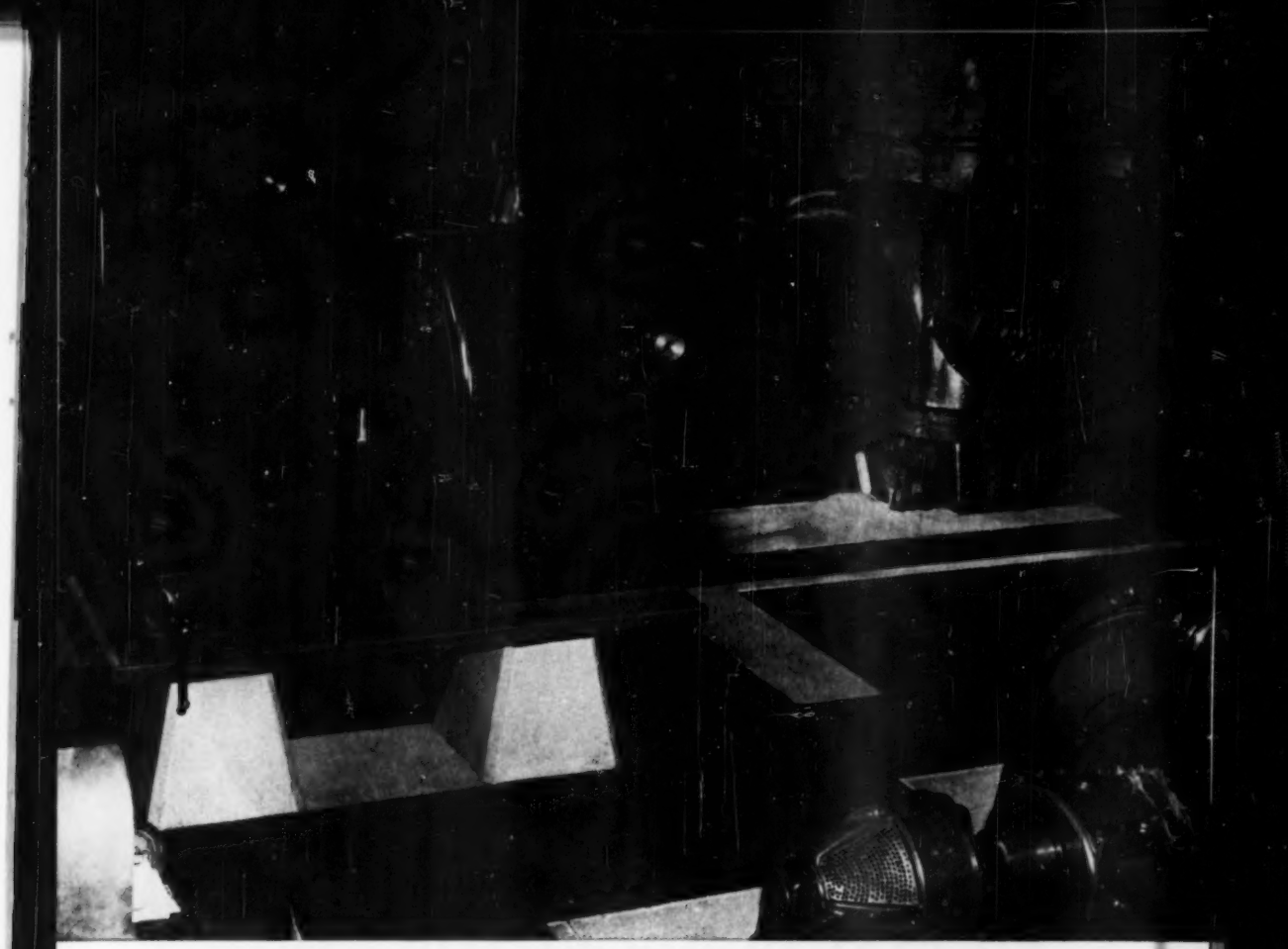
*Reg. U.S. Pat. Off.

Because of its unique structural design, the GUARDIAN gasket compresses and rebounds instantly and repeatedly to conform with expansion and contraction caused by vibration or changes in temperature. Keeps joints *permanently* tight.

For long, trouble-free service, use GARLOCK GUARDIAN gaskets against steam, oils, gases or liquids at the highest pressures and at temperatures up to 1000°F—on pipe flanges, boiler manhole and tube plates, oil refinery equipment or any other application where operating conditions are unusually severe.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK PACKINGS, GASKETS AND OIL SEALS



These turbine lubrication savings can be yours . . .

Simply by your choice of turbine oil, you can eliminate the cost, the time and the labor of replacing turbine oil. You can eliminate also the need for removing turbine oil for treating and the need for cleaning oil systems. Evidence that you can make these savings is supplied by S. H. Smith, superintendent of the Board of Public Works, South Haven, Michigan. He reports:

"When the first of our three present turbines was installed in 1936, we filled it with Nonpareil Turbine Oil. This practice was followed with each of the other two turbines. *In 13 years' use of Nonpareil, we have had no shutdowns resulting from dirty oil or from the necessity of replacing oil.* It has not been necessary to clean the oil. Semi-annual tests have shown that the oil has not deteriorated in any way."

Your switch to Nonpareil Turbine Oil will insure safe and economical lubrication, not only for 13 years, but for the *life* of your turbines. You receive with each fill of Nonpareil a written guarantee that the oil will last as long as the turbine and that its acidity will stay below a neutralization number of 0.15 mg. KOH/gm. Find out from a Standard Oil Lubrication Engineer how Nonpareil has lived up to its guarantee, how it has reduced utility lubrication costs as much as 68%.

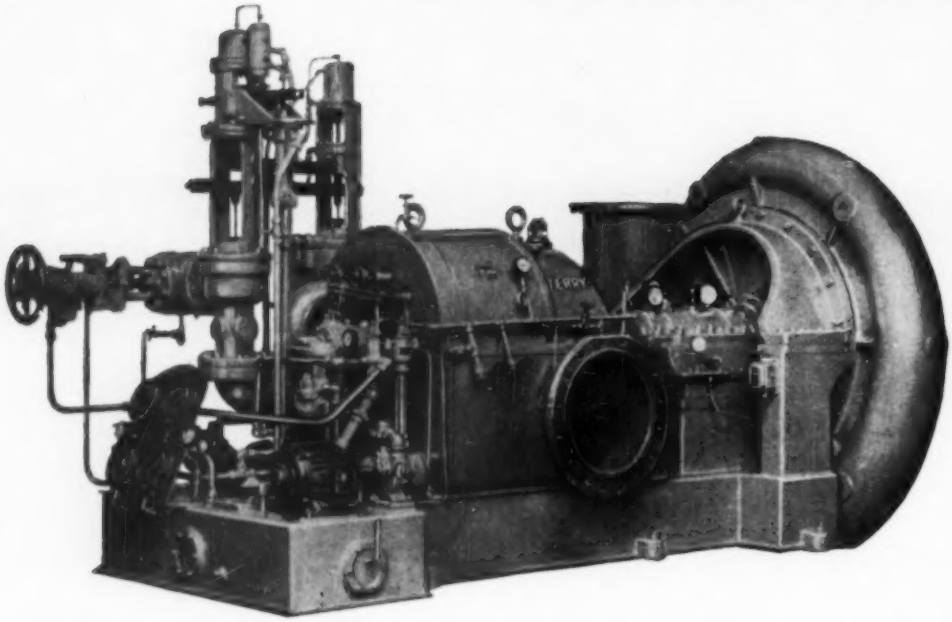
NONPAREIL
Turbine Oil

"WILL OUTLAST YOUR TURBINE"

Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA) STANDARD

The TERRY TURBINE



SPECIAL PURPOSE TURBINE

FOR OPERATION UNDER ALL THESE CONDITIONS:

1. Straight, high-pressure, condensing
2. Straight, low-pressure, condensing—putting to work excess low-pressure steam.
3. Mixed pressure — using the low-pressure steam available, with only enough high-pressure steam required to drive the compressor
4. Condensing bleeder operation — providing clean, low-pressure steam for heating or process work

. . . and the speed under any of these conditions can be varied from 2800 to 4750 rpm.

This is but one example of many unusual combinations developed by Terry to meet out-of-the-ordinary requirements in turbines up to 2000 hp. Information on a special-purpose turbine for your specific requirements will be gladly furnished.

T1177

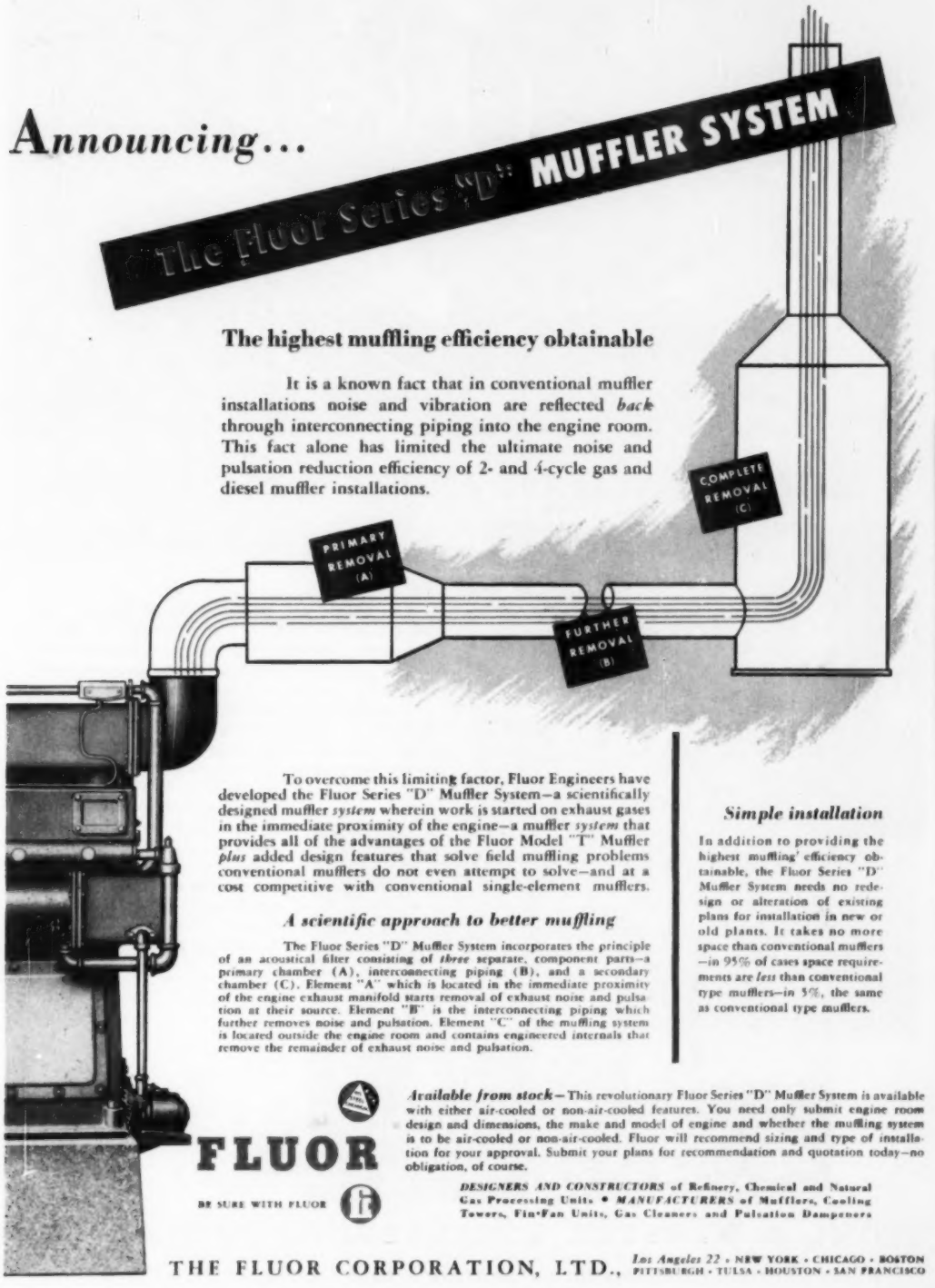
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Announcing...

The Fluor Series "D" MUFFLER SYSTEM

The highest muffling efficiency obtainable

It is a known fact that in conventional muffler installations noise and vibration are reflected *back* through interconnecting piping into the engine room. This fact alone has limited the ultimate noise and pulsation reduction efficiency of 2- and 4-cycle gas and diesel muffler installations.



To overcome this limiting factor, Fluor Engineers have developed the Fluor Series "D" Muffler System—a scientifically designed muffler *system* wherein work is started on exhaust gases in the immediate proximity of the engine—a muffler *system* that provides all of the advantages of the Fluor Model "T" Muffler *plus* added design features that solve field muffling problems conventional mufflers do not even attempt to solve—and at a cost competitive with conventional single-element mufflers.

A scientific approach to better muffling

The Fluor Series "D" Muffler System incorporates the principle of an acoustical filter consisting of *three* separate, component parts—a primary chamber (A), interconnecting piping (B), and a secondary chamber (C). Element "A" which is located in the immediate proximity of the engine exhaust manifold starts removal of exhaust noise and pulsation at their source. Element "B" is the interconnecting piping which further removes noise and pulsation. Element "C" of the muffling system is located outside the engine room and contains engineered internals that remove the remainder of exhaust noise and pulsation.

Simple installation

In addition to providing the highest muffling efficiency obtainable, the Fluor Series "D" Muffler System needs no redesign or alteration of existing plans for installation in new or old plants. It takes no more space than conventional mufflers—in 95% of cases space requirements are *less* than conventional type mufflers—*in* 5%, the same as conventional type mufflers.

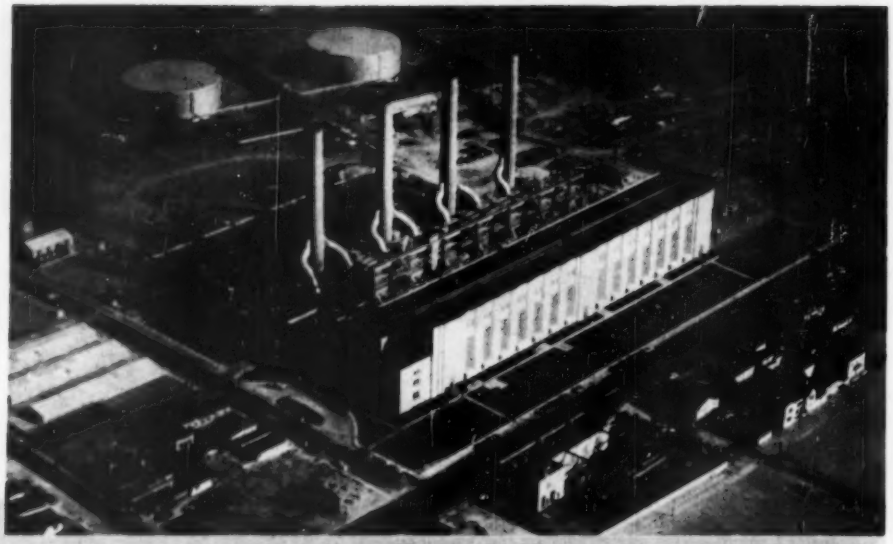
Available from stock—This revolutionary Fluor Series "D" Muffler System is available with either air-cooled or non-air-cooled features. You need only submit engine room design and dimensions, the make and model of engine and whether the muffling system is to be air-cooled or non-air-cooled. Fluor will recommend sizing and type of installation for your approval. Submit your plans for recommendation and quotation today—no obligation, of course.

FLUOR

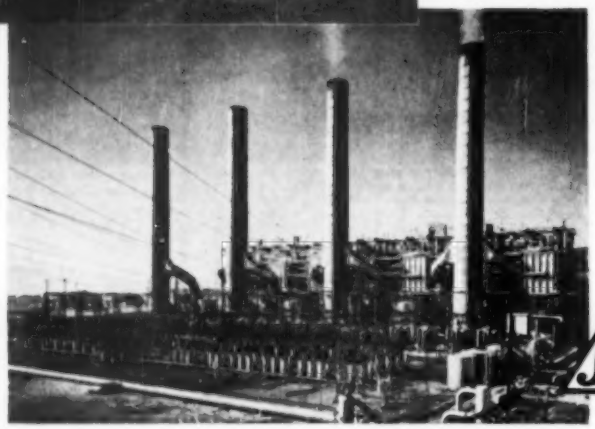
BE SURE WITH FLUOR

DESIGNERS AND CONSTRUCTORS of Refinery, Chemical and Natural Gas Processing Units • ***MANUFACTURERS*** of Mufflers, Cooling Towers, Fin-Fan Units, Gas Cleaners and Pulsation Dampeners

THE FLUOR CORPORATION, LTD., *Los Angeles 22* • NEW YORK • CHICAGO • BOSTON PITTSBURGH • TULSA • HOUSTON • SAN FRANCISCO



HELPING TO MAKE THE WONDERS *of* SO. CALIFORNIA *more wonderful*



The 280,000 kw Redondo Steam Station was constructed to keep pace with the rapidly growing power demands of this region. Semi-outdoor design combines economy of construction with operating comfort and convenience and the entire structure has been built to resist the stress of possible earthquake shock. Unique is the provision for control of marine growth through thermal shock during periodic reversal of salt water flow in the two 2,000 foot intake and discharge tunnels which obtain condenser circulating water from the Pacific Ocean.

Stone & Webster Engineering Corporation designed and constructed the Redondo Steam Station for Southern California Edison Company.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

"Ready-made" PIPE HANGER for a "made-to-order" FIT

Look how closely this 8-inch steam main is tucked up under the roof. And, at 410 p.s.i. and 550° F., this piping was bound to move up and down enough to need flexible support. Just the hanger to fit this situation was ready and waiting right in the Grinnell Pipe Hanger Catalog 10-D . . . the Pre-Engineered Spring Hanger fig. B268, type G.

Every pipe suspension problem is pre-solved for you by Grinnell ready-to-install hangers and supports. You can get a copy of Catalog 10-D from your Grinnell branch warehouse or local Grinnell jobber.

100th ANNIVERSARY PIPING

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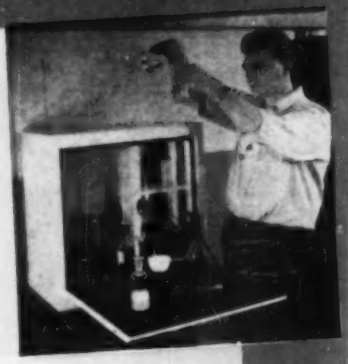
THE *Nalco* SYSTEM OF WATER TREATMENT

Backs Your Routine Plant Testing....



Spectrographic analysis of boiler water sample in the Nalco Laboratories.

with Scientific Laboratory Analysis

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place
Chicago 38, Illinois

Canadian inquiries should be addressed to Alchem, Limited, Burlington, Ontario

NALCO System service does not stop with your original plant survey and chemical treatment recommendations . . . One of the principal reasons Nalco System plants *continue* to get water treatment results, year after year, is that Nalco field and laboratory service back routine plant testing and control procedures with careful analyses and regular surveillance of all conditions relating to your overall water treating problems.

Permanent water treatment security with The Nalco System can be started promptly at your request. Call your Nalco Representative today — or write direct.

THE *Nalco* SYSTEM • Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

PUMPS, COMPRESSORS

101 **Centrifugal Chemical Pumps** — Twelve-pp Bulletin W-350-B11 describes and illustrates some of manufacturer's pumping equipment used in the chemical process industries. Gives a complete explanation of company's mechanical seal designed to prevent leakage of corrosive liquids, and describes Worthite, a corrosion resistant metal. Photos show pumps, seal, and installations. Worthington Pump and Machinery Corp.

102 **Vertical Turbine Pumps**—Oil lubricated and water lubricated turbine pumps are described and their column assemblies illustrated by large sectional drawings, in color, in 8-pp Bulletin P1-178A. Stresses adaptability afforded by optional driving and construction arrangements. Bulletin also discusses and illustrates company's research and engineering facilities. A. O. Smith Corp.

103 **Rotary Pumps**—Catalog LG, 4 pp, provides cutaway drawings and descriptions of six different types of company's "IMO" rotary pumps, designed to handle residual and distillate fuel oils, crude oils, lubricating oils, viscous fluids and similar liquids. Discusses reliability, high speeds, freedom from pulsation, accessibility and other advantages of these pumps in capacities ranging from 0.5 to 1000 gpm for pressures to 500 psi, and to 150 gpm for pressures to 1500 psi. DeLaval Steam Turbine Co.

104 **Centrifugal Pumps**—Four-pp Bulletin 246 introduces company's two-stage volute centrifugal pumps, giving complete specifications and engineering data. Pump's design and construction are shown by means of a large cutaway drawing. Includes dimensions, rating table. Warren Steam Pump Co.

105 **Pump Data**—Bulletin 725.4, 8 pp, is devoted to engineering data on manufacturer's stainless steel centrifugal pumps for handling corrosive liquids. Includes sectional drawings and photo of assembly, as well as discussion of design features, performance curves, specifications and dimensions. Goulds Pumps, Inc.

106 **Centrifugal Pumps**—Bulletin 53, 16 pp, covers two types of vertical self-priming centrifugal pumps—a coupling connected unit with bearing bracket, and one with no bracket and the impeller mounted on an extended motor shaft. Sectional drawings are used to illustrate seal design and priming action and all parts of both pump assemblies. Also presented in this informative booklet are instructions on installation and care of the pumps and pointers on operating them. The LaBour Co., Inc.

107 **Centrifugal Compressors**—Twelve-pp Form CH-6-49 presents data on company's pedestal-type contrifugal pipe line compressors and expansion turbine. Covers design features, construction and advantages of this equipment and is illustrated with photos and sectional drawings. Clark Bros. Co., Inc.

ELECTRICAL

108 **Recloser Data**—Bulletin B-4330, 4 pp, describes operation of company's new 100-amp type GR recloser. Step-by-step description is illustrated by diagrams and semi-pictorial drawings. A table is given showing minimum tripping currents for the five coil sizes available and maximum interrupting capacities at common operating voltages. Dimensions are given for brackets used for crossarm, extended-pole or substation or direct-pole mounting. Westinghouse Electric Corp.

109 **Synchronous Motors** — Low speed synchronous motors of the pedestal, engine, flywheel and vertical types for all industrial applications are presented in 4-pp Bulletin 502. Includes specifications, starting characteristics. Contains many photos of installations. The Ideal Electric and Mfg. Co.

VALVES AND PIPING ACCESSORIES

110 **Ball Valves** — Company's line of valves actuated by the venturi-ball principle are fully described in 16-pp Bulletin 102. This well illustrated catalog covers their principle of operation, and provides necessary engineering data, specifications and sizes on the line which includes "whistle," bar stock, cast steel and stainless steel and forged valves. Standard handwheel, quick opening lever, diaphragm and other valve types are described and their special advantages given. Paul Valve Corp.

111 **General Service Valves** — Bulletin E-160, 16 pp, describes and illustrates the design and construction of company's quick-operating valves, explaining their application to blow-off service and on fire protection, chemical process, soot blower, water column blow-down, and other types of pipe lines. Included are tables of dimensions, weights and list prices for straight lever and rack-and-pinion types, inside packed and with outside stuffing box and with screwed or flanged ends. Everlasting Valve Co.

112 **Instrument Valves**—Bulletin 491, 4 pp, contains dimensions, weights, prices and operating data on forged steel valves for use on orifice meters, regulators, instrument panels, gage lines, by-pass lines and similar applications. Design features are discussed and illustrated by large cutaway drawing. Valves described have ratings of 6000 lb WOG at 100 F or 1500 lb sp at 850 F with carbon steel bodies and 1500 lb sp at 1000 F with stainless steel bodies. Edward Valves, Inc.

113 **Shut-Off Cocks**—Bulletin 100-1 covers company's line of brass and iron cocks recommended for shut-off service where long life and trouble-free operation are important factors. Many photos and sectional drawings are included with brief descriptions of acid metal, gland-packed, and roundway cocks, red brass gas cocks and other types. Also described and illustrated are stop, check, non-return and transfer valves, as well as swing joints. Belfield Valve Div., Minneapolis-Honeywell Regulator Co.

114 **Gage and Valve Accessories**—Unit 119 presents optional features and accessories for use on company's line of gages and valves. Items described and illustrated include equalizing plates, optional gage and valve connections, double seating and end stems, gage glass protectors, scales, gage illuminators and other equipment. Jerguson Gage & Valve Co.

115 **Pressure Safety Appliances**—Safety and relief valves, pressure indicating gages, whistles and specialties for steam, air, oil, chemical and hydraulic service are catalogued in Information Bulletin 502-D, 4 pp. Includes photos of typical models, sizes, specifications and application data. J. E. Conergan Co.

116 **Strainers**—Bulletin S-202, 4 pp, describes and illustrates company's fine screen strainers for steam traps, re-

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duating valves and other pipe line equipment. Tells why strainers are needed; discusses special features and construction details of these strainers. Includes pressure and screen data tables, suggestions for installing, and dimensions, weights and prices. Yarnall-Waring Co.

117 **Liquid Shock Absorbers**—This is a 3-pp bulletin featuring four models of a compact shock absorber for eliminating shock and hammering in pipe lines carrying water or petroleum products. Description, applications, installation instructions and list prices are included. B-S Products Corp.

INSTRUMENTS AND CONTROLS

118 **Recording Oscillographs**—Sixteen-pp Bulletin CEC-1300A discusses the applications, operation and features of manufacturer's multichannel recording oscillographs, sample records of actual applications are presented along with detailed assembly drawings and photos of instruments and parts. A section, complete with technical information and response curves, is devoted to galvanometers. Accessories, related equipment, and company's customer service plan are presented. Consolidated Engineering Corp.

119 **Timing Instruments** — Bulletin 142, 4 pp, describes and illustrates four timers, giving their applications, advantages, specifications and prices. Covers a new impulse timer, also presents an interval timer, process timer, and multiple circuit timer. Zenith Electric Co.

120 **Electronic Controls** — Bulletin PG 4910, 62 pp, presents 45 case studies on cutting production costs with electronic controls, each describing an industrial control problem solved through the use of electronics. These applications were chosen for their general interest and include flame failure safeguards, liquid level controls, mounting, diaphragm valve controls, metering of liquids, seam detection, smoke detection, and others. Photoswitch, Inc.

121 **Industrial Controls** — Illustrated Bulletin F-3941, 12 pp presents application and engineering data on company's motor-operated valves, control motors, temperature and humidity controls and control systems. Includes dimensions, capacities, steam flow chart and explanation of basic types of control and terminology used. Barber-Colman Co.

HEATERS, HEATING

122 **Deaerating Heaters**—Bulletin W-101 outlines in 8 pp the principles of deaeration, fully describes the design, operation and applications of company's deaerating heaters, and explains their distinctive features. Both vertical and horizontal types are pictured, and the illustrations also include flow sheets for this type of apparatus in conjunction with other feedwater equipment in intermediate pressure, high pressure, and central station boiler plants. Graver Water Conditioning Co.

123 **Unit Heaters**—Part 3, Section 3 of Catalog 54 in 34 pp covers the types and applications of company's volume-type heaters, internal firebox heaters, horizontal and vertical fluid jacket type heaters. Explains their use in multi-unit heating systems and in such special applications as heating stock tanks, gas sweetening, steam generation and batch treating. Fully illustrated, catalog tells how each heater is built and how it works and includes specifications. Black, Sivalls and Bryson, Inc.

124 **Heating Unit**—This bulletin presents advantages of company's gas- or oil-fired self-contained industrial heating unit, explaining its operation, simplicity of installation, and describing and illustrating some of its applications. Includes specifications. Also contains engineering data to help analyze industrial heating problems, including procedures to determine heat load, fuel consumption. Thermobloc Div., Frat-Daniel Corp.

125 **Space Heaters**—The advantages of using company's warm air space heaters in the tempering of make-up air are fully explained and illustrated in Bulletin 520, which also discusses other applications of these heaters. Several installations are pictured and a typical example of providing tempered make-up air in a large foundry is provided. Dravo Corp.

126 **Low Pressure Heating Units**—A 15 psi steam boiler and a 40 psi hot water or fluid heater are presented in this 8-pp bulletin. Discusses their application in the heating of small plants and in the generation of steam for small industrial requirements. Heater shell and internal firebox construction are also described. Includes capacities, specifications, dimensions. Black, Sivalls and Bryson, Inc.

ENGINES AND ACCESSORIES

127 **Radial Engine**—Bulletin 172, 8 pp, describes and illustrates company's new two-cycle 11-cylinder, 14 by 16 in. engine which develops 1800 hp at 400 rpm, 1250 kw, with scavenging blower motor requiring 60 kw input, leaving a net capacity of 1170 kw. A section view illustrates the crankshaft and gear assembly. A cross-section view of the entire engine and pressure system of lubrication and piston cooling is also shown. Bulletin describes engine's operation as an oil-burning Diesel and also as a spark-fired gas engine. Nordberg Mfg. Co.

128 **Fuel Vaporizer**—This 4-pp bulletin describes company's completely redesigned fuel vaporizer to power gas engines. It provides full operational data on this power source; explains process by which the vaporizer strips volatile fractions from pipe-line or lease crude and makes them directly available to the engine carburetor; gives basic crude requirements. Illustrations include a detailed flow diagram and dimensional sketch of the 40 hp fuel vaporizer. Specifications and capacity tables cover the 20, 40, 110 and 300 hp units in production. Black, Sivalls and Bryson, Inc.

COAL HANDLING

129 **Conveying Systems**—The unloading and conveying of pulverized coal and other dry pulverized material is discussed and illustrated in 24-pp Bulletin PK-25. Text covers the complete system and its operation, also the stationary pump and related equipment and is illustrated by photos and dimensional drawings, with available sizes listed. Conveying equipment installed in mixing plants, cement plants, foundries and other industries is described and pictured. Also presented are company's air compressor for use with conveying systems and remote-control unloader. Fuller Co.

130 **Small Crushers**—"For Better Testing and Small Scale Reduction" is the title of this 6-pp bulletin describing in detail the many practical applications of company's small crushers, grinders, and shredders for the reduction of coal, by-products, chemicals, clays and many other products. Typical installations are clearly diagrammed and explained. Special attention is devoted to construction features and functional advantages of the different mills as applied to various reduction jobs. American Pulverizer Co.

TOOLS AND SHOP EQUIPMENT

131 **Reversible Ratchet Wrenches**—Bulletin F-12 is a data sheet on reversible ratchet wrenches for heavy duty use. Illustrates wrench, discusses its design and applications, and includes sizes and full ordering information. Greene, Tweed & Co.

132 **Torches, Soldering Products**—Manufacturer's complete line of soldering products is covered in 24-pp Catalog 85. These include gasoline and kerosene blow torches, self generating alcohol blow torches, electric soldering irons, solder, spilcer's furnaces, paraffin supplies, and compound kettles. Also described are oilers, grease buckets, shop torches, and steel gongs and shells. Equipment is illustrated by photos and sizes and prices are listed. P. Wall Mfg. Co.

MISCELLANEOUS

133 **Water Hardness Test**—This technical bulletin presents a test procedure for determining hardness of water, by use

(Continued on page 116)

JANUARY, 1950

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Over 1,000,000 NEW kw's from plants using KELLOGG power piping!

ONE million kilowatts of generating capacity require a whale of a lot of power piping. And when you reflect that this volume is confined solely to completed plants and not to piping supplied by Kellogg in the last 25 years, it takes on added significance.

But the actual volume is not so indicative as the reasons behind it. For example, most of these piping installations began on Kellogg's exclusive apparatus for determining stresses in piping layouts . . .

. . . Two called for unusual experience in welding, for they were the first 1050°F. installations employing stainless steel . . .

. . . Another required the fabrication of unique transition pieces in which two metals varying in thermal expansion by 50% were *Kelcaloyed* as single bi-metallic pieces with ends formed of different metals . . .

. . . On several of the jobs availability of experienced supervisors for welding and stress relieving on the site was the key requirement . . .

. . . And all of the installations reflected the results of extended study of such problems as graphitization, creep stress rupture that has been going on for years in Kellogg metallurgical laboratories.

Together these plants, eventually to provide more than one million kilowatts—and those of the past and future—indicate the extra value inherent in Kellogg's participation in the high temperature and pressure piping phase of power plant expansion and construction.

Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Complete facilities for the fabrication of steel products from simple forgings to specially cast bi-metallic devices.

Top welding performance in shops and in the field by welders accustomed to working under X-Ray checks.

Quality control, devised by metallurgical experts, embracing forming, heat treating and non-destructive testing.

Vessels
Exchangers
Condensers
Process Piping
Forged and Welded Fittings
Radial Brick Chimneys

★

The M. W. Kellogg Company, Inc. (A Subsidiary of Pullman, Inc.) — Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris.

SUN "JOB PROVED" PRODUCTS CUT COSTS,

Sun products have been "Job Proved" in the lubrication of almost every type of mining, manufacturing, power, and transportation equipment . . . in refrigeration and air-conditioning . . . in metal cutting, tempering, and quenching . . . in the processing of textile fibers, leather, natural and synthetic rubbers . . . in the impregnation of electrical, electronic, and packaging materials of many kinds.

To help you solve your production problems, Sun Oil Company offers a wide selection of "Job Proved" petroleum products, plus the experience of Sun Engineers. Their know-how and detailed product information are yours for the asking. Call your local Sun office, or write Dept. PN-1.

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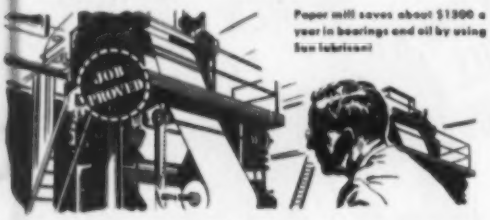
INDUSTRIAL OILS

SUNVIS 900 OILS—High-viscosity-index, paraffinic-type oils—of uniform O F pour point—fortified against rust, corrosion, oxidation, and sludge. The finest available lubricant for turbines, hydraulic systems, and similar applications.

SUNVIS HD 700 OILS—High-viscosity-index oils containing additives which minimize oxidation and give detergency. Ideal lubricants for internal combustion engines subjected to continuous heavy loads under the most adverse conditions.

SUNVIS OILS—Solvent-refined paraffinic-type oils of uniform high viscosity index, low pour point, and low carbon content. Especially suitable for application to long-time use in all types of industrial reservoirs and circulating systems.

DYNAVIS OILS—Low-pour-point, high-viscosity-index, inhibited oils, containing an additive which helps prevent formation of harmful corrosive and sludge-forming acids. Well suited for engines fitted with alloy bearings and operated at high temperatures.



Paper mill saves about $1300 a year in bearings and oil by using Sun lubricant

SOLNUS OILS—Well-refined straight mineral oils. Stand up under hard use for long periods of time. Recommended for use in machine tools, air compressors, certain types of diesels, etc.

CIRCO OILS—Used for general lubrication of industrial machinery when straight mineral oils are required.

SUNTAC OILS—100%-petroleum products which have been compounded to increase their adhesiveness. Recommended for general lubrication of all machines subjected to sudden shocks and load reversals. Cling to the parts to be lubricated.

STEAM CYLINDER OILS—High flash and fire point lubricants for either saturated or superheated steam conditions and for worm-gear speed-reduction units.

SUN CAR JOURNAL OILS—Dark oils meeting A.A.R. Specifications. For use in waste-packed bearings of railroad equipment.

SUN DELAWARE OILS—Dark oils for general lubrication on older types of industrial machinery.

SUNOCO WAY LUBRICANT—For use on tableways. Eliminates chatter and scoring . . . resists corrosion. Has good metal-wetting and adhesive properties, ample viscosity, and E. P. qualities.

SUN MARINE ENGINE OILS—Compounded with special emulsifying agents in order to provide adhesion to, and lubrication of, working parts in the presence of water. For the lubrication of bearings, eccentrics, crossheads, and various other parts of steam engines.

ROCK DRILL OIL—High-film-strength adhesive oil. For use in jackhammers, stopers, drifters, and similar equipment.

INDUSTRIAL GREASES

SUN CUP GREASES—Water resistant. For grease-cup and grease-gun application when service is normal.

SUN GUN GREASES—Smooth greases made with medium-viscosity oil. Stable under pressure in power and booster guns.

ADHESIVE PRESSURE GREASES—Won't drip or splash. Excellent lubricants for open-gear applications.

SUN DARK PRESSURE-SYSTEM GREASES—For power-driven central grease lubricating systems in heavy industries. Also used as a "medium cup grease."

SUN MINE CAR GREASES—Available in several grades. Suitable for both antifriction bearings and plain-bearing cavity-type wheels.

SUN MINING MACHINE LUBRICANT—Semifluid. For use where a light but adhesive grease is required. Resists separation and decomposition.

Chemical plant saves about $8000 per year by adopting Sun Pressure Grease

SUN ROLLER BEARING GREASES—For use on electric motors and generators and high-temperature machinery equipped with ball or roller bearings.

SUN GEAR COMPOUNDS—Black adhesive open-gear compounds and

"JOB PROVED" IN EVERY INDUSTRY

SUN PETROLEUM

SPEED PRODUCTION, IMPROVE QUALITY

wire-cable greases. Recommended for power presses, mining machinery, worm reduction mills, crushers, pump gears, etc.

SUNOCO TRACTOR ROLLER COMPOUND—For crawler-type tractors. Provides good lubrication with exceptional sealing qualities.

METALWORKING OILS

SUNICUT—Straight (non-emulsifiable) transparent cutting oils. Recommended for automatic screw machines and heavy-duty machining operations. Permit high speed production with excellent finishes, long tool life.

SUNOCO EMULSIFYING CUTTING OIL—A self-emulsifying oil which produces a stable white emulsion. Efficient and economical cooling and lubricating medium for turning, milling, drilling, and other metalworking operations on both ferrous and nonferrous metals. It is also an excellent grinding coolant.

SUN QUENCHING OILS—Specially refined oils designed to aid development of maximum physical properties in a wide variety of steels.

SUN TEMPERING OILS—Specially refined oils for tempering steel. Because of their low carbon content and stability under heat, these oils have an unusually long service life.

Machine shop uses Sunicut 209 W as a cutting and lubricating oil —saves up to $1000 a year

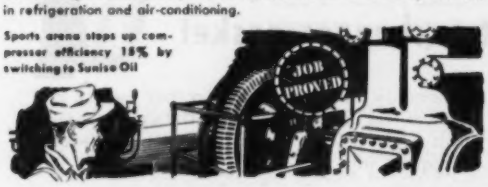
SUN ROLLING OILS—Straight and emulsifying oils which will permit maximum production in rolling steel, aluminum, brass, and copper.

SUN ANTI-RUST COMPOUNDS—Petroleum-base oils with chemical additives designed to prevent the rusting and corrosion of steel.

REFRIGERATION OILS

SUNISO REFRIGERATION OILS—Have extremely low pour points, extremely low wax-separating characteristics, a high degree of stability and long life. Initially neutral and resistant to formation of detrimental acids under service conditions. Sunisо Oils are high quality oils suitable for both high- and low-temperature operations. The most widely used oils in refrigeration and air-conditioning.

Sports arena steps up compressor efficiency 15% by switching to Sunisо Oil



TEXTILE-PROCESSING OILS

SUNOTEX TEXTILE OILS—Designed to impart certain additional properties to various forms of fibers during their processing from the fiber state into a manufactured product. All Sunotex textile oils are emulsifiable in water. Highest rating in fadometer tests.

SUN COTTON CONDITIONING OILS—Pale mineral oils which condition the cotton. They prevent waste by cutting down excessive amounts of "fly" (fine air-borne lint particles).

Worsted mill obtains easier scouring, better quality, larger yield with Sunotex WO-220

SUN ASBESTOS FIBER CONDITIONING OIL—Used for spraying on the asbestos during processing. Fibers are kept from being damaged or broken down, and harmful dust is minimized when this product is used.

SUN CORDAGE OILS—Generally used alone, but are adaptable to various formulas used by cordage manufacturers. Selected products, highly compatible with additives.

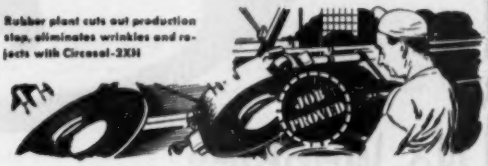
RUBBER-PROCESSING AIDS

CIRCOSOL-2XH—An elasticator and processing aid for natural rubber and especially for GR-S. Outstanding for sponge rubber.

CIRCO LIGHT PROCESS AID—A processing agent and excellent softener for natural rubber, natural rubber reclaims, and neoprene synthetic rubber. Used for GR-S to some extent.

SUNDEX-53—An inexpensive product suitable for processing GR-S and blends of GR-S and natural rubber. An established processing aid for rubber footwear stocks and semihard rubbers.

Rubber plant cuts out production step, eliminates wrinkles and rejects with Circosol-2XH



CIRCOMAR-5AA—A black-colored product for processing natural and GR-S rubber used in tire-making. Also used in reclaiming natural-rubber scrap. Replaces asphalt fluxes. Free-flowing at room temperature.

WAXES

Sun's new wax plant will be completed in 1949. Its many refining innovations and extreme flexibility will permit new types of waxes to be manufactured in large quantities—a procedure heretofore impracticable. A wide range of fully refined paraffin and microcrystalline waxes will be "tailor-made" to meet the requirements of virtually all major industrial applications. Pilot plant samples of several grades are now available.

MISCELLANEOUS INDUSTRIAL PRODUCTS

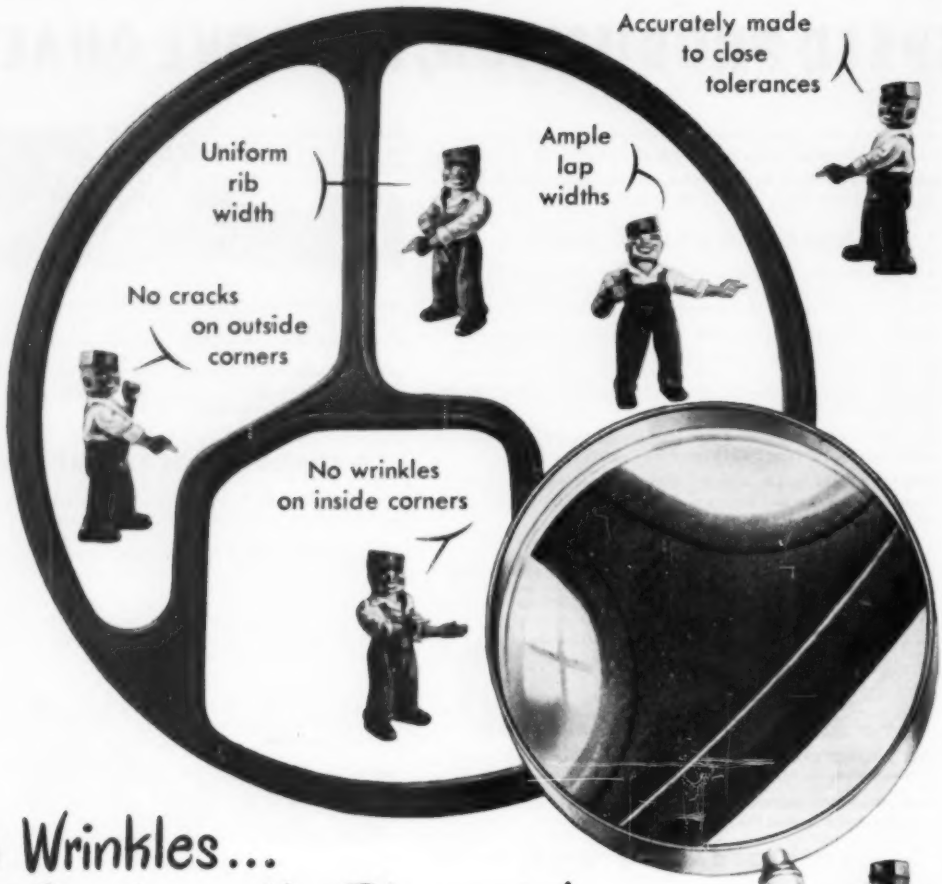
SUN SOLVENTS—Sun Spirits for the thinning of paints, varnishes, and enamels, and for metal-cleaning . . . a pure, water-white petroleum solvent free of corrosive sulphur. Other Sun solvents with special properties are available for the chemical industry.

SUN LEATHER OILS—Mineral-base leather oils. Used for obtaining the desired tensile strength, proper temper, and controlled moisture content. Maintain a light even color . . . mix well . . . distribute evenly.

"JOB PROVED" IN EVERY INDUSTRY

PRODUCTS

SUNOCO


Accurately made to close tolerances
Uniform rib width
Ample lap widths
No cracks on outside corners
No wrinkles on inside corners

No Wrinkles... No Cracks... No Blowouts!

no place for leaks in THIS heat exchanger gasket

TAKE A CLOSE LOOK at the Goetze heat exchanger gasket shown above. Note the absence of cracks on outside corners . . . of wrinkles on inside corners . . . the uniform width of the ribs . . . the generous overlap of the metal jacket.

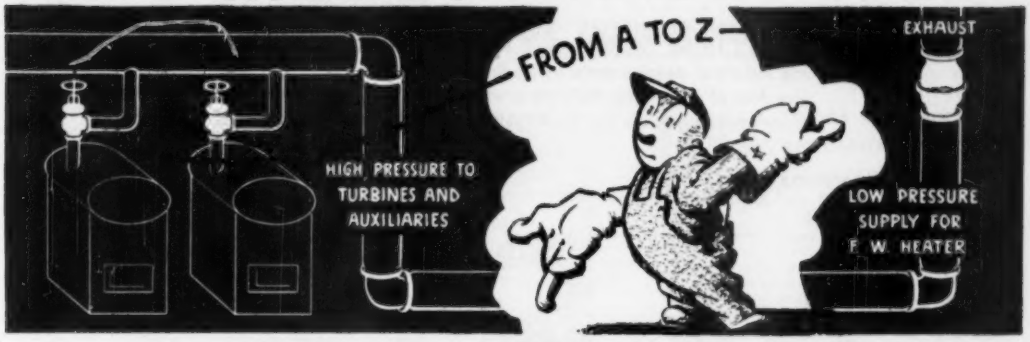
Attention to such important details is typical of the kind of care that goes into the forming of these custom-made gaskets. It is the secret of their dependable service—why you can count on them to stay on the job indefinitely without leaks or blowouts. And it's the reason they pay off in terms of less down-time and in the savings that result when gaskets *don't* have to be replaced at frequent intervals.

• • •

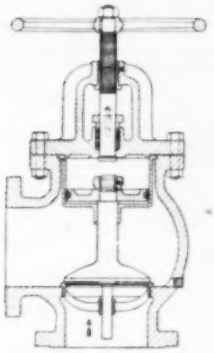
You can have Goetze heat exchanger gaskets made in any size or shape. Estimates and recommendations will be furnished promptly on request. Write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville *Goetze* Gaskets

SAVE MONEY IN YOUR PLANT



—with FOSTER AUTOMATIC VALVES



FOSTER AUTOMATIC NON-RETURN Stop and Check Valve, Type 2

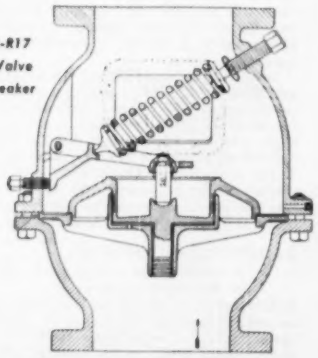
A . . . On your boiler drums, Foster Automatic Non-Return, Stop and Check Valves save money by doing their job perfectly—with the absolute minimum of attention—for years. It is not unusual to find these valves still giving good service after 25 or 30 years and more. Today's valves are even better.

There's nothing skimpy about a Foster Type 2. Full pipe area means negligible pressure drop across the valve. Heavy duty, through bolted construction makes it safe to work under when the boiler is down. Low pressure types to 250 lbs. (stocked) have semi-steel bodies, bronze trimmed, with stainless steel seat rings; high pressure types to 1,500 lbs. have cast steel bodies, trimmed with special heat resisting, corrosion resisting alloys. Piston chambers are renewable. They're built for lifetime service. Globe, angle, or elbow, from 2½" to 12".

Z . . . The R-17 Back Pressure Valve saves money by keeping the pressure where you want it on the exhaust side—for your feed water heater or other low pressure equipment—with a minimum of maintenance. Large pipe area, and large valve area mean low pressure drop across the valve, and sensitive action at low pressures. Saves make-up steam. Adjustable in ounces.

The R-17 has no outside stuffing boxes or external weights. Loading spring is on the atmosphere side of the valve and is accessible for inspection through a large handhole. Renewable seat ring and dash pot. 2½" to 20", (with sizes from 4" to 12" stocked).

Foster Type 34-R17 Back Pressure Valve and Vacuum Breaker



• • • All along the line—Foster Pressure Regulators, Temperature Regulators, Pump Governors, Float Valves, Safety Valves, Check Valves, Relief Valves and Safety Valves are designed and built to save money, by giving reliable, trouble free regulation with a minimum of maintenance. When you select the proper Foster Valve and install it correctly, you are making a sound investment, backed by more than 70 years of practical experience in building good valves, and our reputation for service.

FOSTER ENGINEERING Company

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . AUTOMATIC STOP AND CHECK VALVES . . . ALTITUDE VALVES . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN VALVES . . . VACUUM REGULATORS OR BREAKERS . . . STRAINERS . . . SAFETY VALVES . . . SIRENS

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NEW EQUIPMENT NEWS

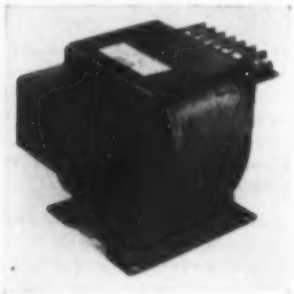
WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.

1—CONTROL TRANSFORMERS

For machine tool use, follow proposed NEMA standards

These transformers are said to be particularly adapted to inductive, low-power factor loads of solenoids, relays, and contactors making up machine tool control equipment. Secondary voltage of these 60-cycle transformers remains above 90 per cent of rated voltage up to a load current of 7 times normal at 20 per cent load power factor.

Size and weight of transformers ½



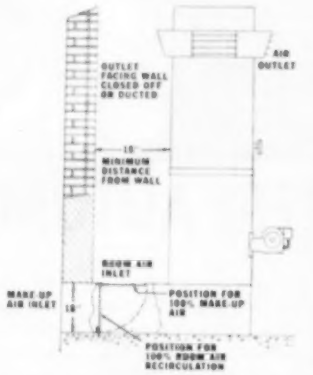
kva and larger are low because of the use of type "C" Hipersil cores, it is noted. Circuit-breaker protection is normally supplied on ratings 0.300-kva and larger while on ratings 0.150-kva and smaller a block is mounted for customers' fuses.

Seven sizes from 0.075 to 1.5 kva are available for 220/440 v primary to 110 v secondary at 60 cycles. Transformers for 50-cycle operation come in six sizes from 0.150 to 1.5 kva for 208/220/380-416/440 v primary to 110/95 v secondary. Three sizes from 0.150 to 0.500 kva are available for 25-cycle operation at 220/440/550 v primary to 110 v secondary. Westinghouse Electric Corp.

2—DIRECT-FIRED HEATER

Is self-contained industrial unit suited for tempering make-up air

A new model Thermobloc is announced as well suited for tempering of make-up air where a ventilating system imposes heavy loads on the heating plant in cold weather. When ventilators are at work, manufacturer points out, air to make-up for the volume ventilated off must enter the building. Infiltration by cracks and doors can, in cold weather, impose a serious overload. To combat this, Thermobloc units can be positioned along the walls with air intake duct running through the wall. This feeds outside air to the units


OUTLET FACING WALL CLOSED OFF OR DUCTED
AIR OUTLET
10' MINIMUM DISTANCE FROM WALL
ROOM AIR INLET
MAKE UP AIR INLET
10'
POSITION FOR 100% MAKE UP AIR
POSITION FOR 100% ROOM AIR RECIRCULATION

where its temperature is raised before it is discharged into the working area.

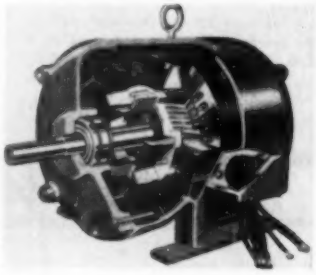
Unit is designed to temper make-up air whether it is used as a plant heating system or as an auxiliary unit. Prat-Daniel Corp.

3—INDUCTION MOTOR

Squirrel cage type, has continuous steel frame for protection

A unique ventilating system has been designed to eliminate hot spots in this motor, manufacturer points out. Ribs supporting the core in the frame are open in the center to permit air to circulate around and cool the back of the core and prevent pocketing of heat. The heated air is exhausted laterally through the baffled feet away from the air inlets. This is said to prevent hot air from being drawn back and recirculated. The closed underside of the frame is intended to prevent the escape of heated air under the motor where it could be picked up and recirculated.

Motor's continuous frame is designed to protect bottom as well as top and sides. Air inlets and outlets are baffled



to meet NEMA specifications for drip-proof protection. Available with low or high voltage windings. Ideal Electric & Mfg. Co.

4—THREAD SEALER

Comes in handy stick form, for carrying in pocket or tool kit

The application of this sealing compound to pipe threads before joints are made up provides a positive seal against gases, brine, acids, water, steam and ammonia at high and low pressures and temperatures, according to manufacturer. Called Thread-Tite, it may be applied to steel, aluminum, iron, brass, plastic, copper, and threads in other materials.

Thread-Tite is also credited with affording protection against seizing or galling. It is said that pipe joints, bolts and studs can be drawn tighter than usual, due to lubricating qualities in the compound, and then easily unscrewed, even after years of service.

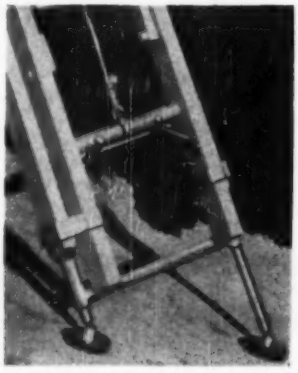
According to manufacturer, Thread-Tite won't harden or dry out, and is unaffected by vibration. As compound is used, the stick may be pushed forward in its case until used up. Stick has metal cap. Armite Laboratories.

5—LADDER ATTACHMENT

For automatically correcting unlevel ground conditions

Designed to provide greater safety for ladder users, the Hydra-lizer has interconnected hydraulic units for displacing oil from one into the other, as ladder is erected, to correct differences in terrain from hillsides to stairways. By moving a foot operated valve lever, the ladder can be instantly locked in any position desired, it is stated.

The unit is designed to be easily attached to all types of ladders, wood or



USE THE NO-OBLIGATION, POSTAGE-PAID CARD ON PAGES 35-36

For every piping equipment need ...Look to CRANE for complete selection

Look at This Fuel Oil Piping, for example. Every item in the system can be supplied by Crane. Yet all equipment shown here represents but a small part of the complete selection available to you when you order through your local well-stocked Crane Branch or Wholesaler. One order covers everything for the job—valves, fittings, pipe and accessories . . . of finest quality brass, iron, steel and corrosion-resistant alloys.

Whether your lines carry steam, water, oil or gas, you'll find everything you need at Crane. It's the **One Source of Supply** complete enough to simplify every piping procedure, from design to erection to maintenance. **One Responsibility** for materials helps you to get a better installation—on schedule. **One Standard of Quality** in every item from Crane assures dependable piping performance from end to end of every system.

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RESPONSIBILITY
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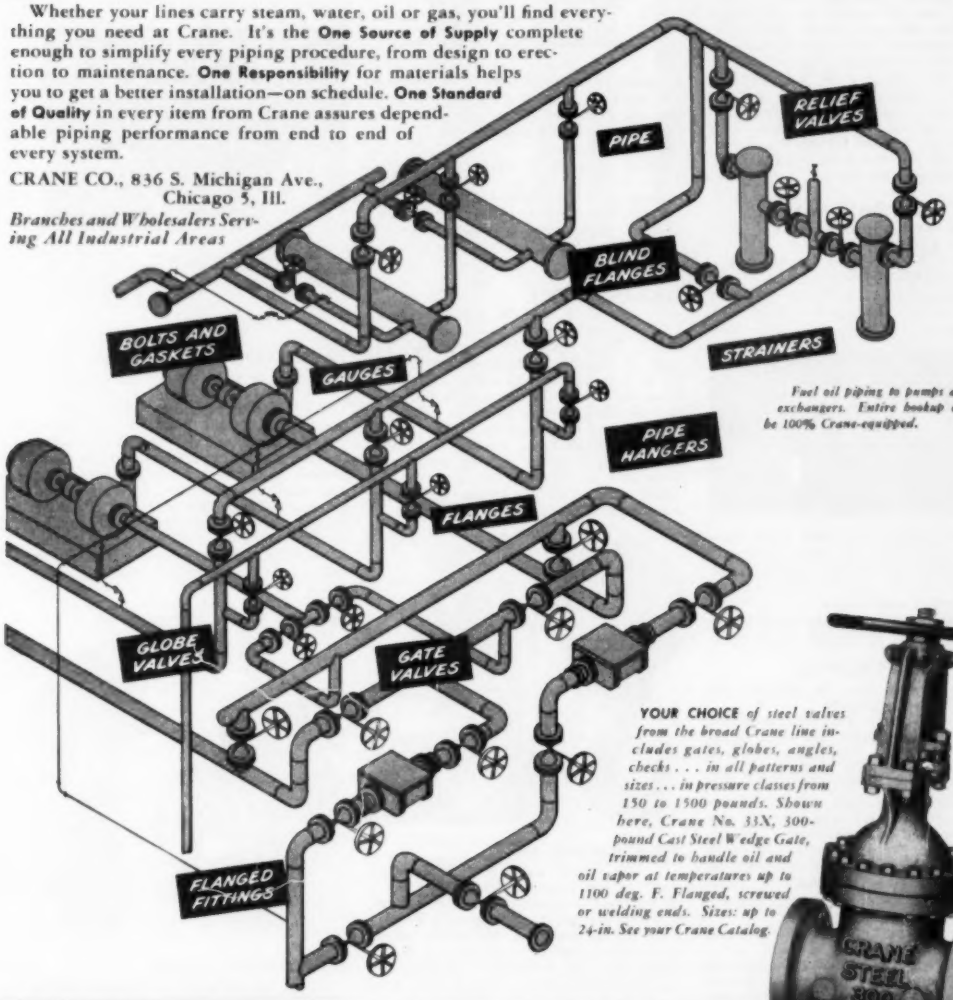

Fuel oil piping to pumps and exchangers. Entire hookup can be 100% Crane-equipped.

YOUR CHOICE *of steel valves from the broad Crane line includes gates, globes, angles, checks . . . in all patterns and sizes . . . in pressure classes from 150 to 1500 pounds. Shown here, Crane No. 33X, 300-pound Cast Steel Wedge Gate, trimmed to handle oil and oil vapor at temperatures up to 1100 deg. F. Flanged, screwed or welding ends. Sizes: up to 24-in. See your Crane Catalog.*

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VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

Mark the numbers of the items you wish to receive on the no obligation, no postage card. Pages 35-36.

metal, straight or flared base. Telescopic steel tubing automatically adjusts to proper width and unit can be reused on ladders of different dimensions, company points out.

The Hydra-lizer is intended to meet the need for a strong, lightweight, automatic ladder equalizer which can operate under all conditions and stand abuse. The ball and socket shoe provided to conform with irregularities of terrain can be instantly flipped up on end for ice, slippery or soft ground conditions, company reports, adding that it's easy to erect ladders and pivot them to position with a Hydra-lizer. Made entirely of steel for working loads of over 500 lb, the unit weighs only 6 lb. Anderson Products Co.

6—CAST STEEL BALL VALVE

In 3 and 4 in. sizes, for general, pipeline, and refinery use

This valve is described by manufacturer as combining the best features of plug cocks, gate and globe valves. It is equipped with a floating ball and resilient, synthetic rubber seat. It is said

to handle fluids faster and more economically and not leak after continued use. Among advantages stressed for this valve are its long service life and quick opening and closing by a quarter-turn of the handle. Rockwood Sprinkler Co.

7—VOLTAGE REGULATOR

For branch lines, is designed for eight-step regulation

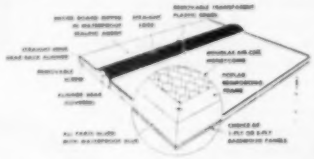
The ML-8 Feeder Voltage Regulator supersedes company's four-step type, at same price. It provides a total of 10 per cent regulation in eight 1¼ per cent steps, in any of the following combinations: 10 per cent raise, 7½ per cent raise to 2½ per cent lower, 5 per cent raise to 5 per cent lower, 2½ per cent raise to 7½ per cent lower or 10 per cent lower. Unit is available in selected kva sizes in 2500, 5000, and 7620 v ratings and corresponding Y-connected voltages.

Other features claimed include an improved tap-changing switch, cover bushings with clamp-type terminals, and a "load-bonus" feature to permit increase in current-carrying capacity up to 160 per cent for the connection arrangement of 5 per cent raise to 5 per cent lower. Transformer and Allied Products Divs., General Electric Co.

8—DRAWING BOARD

Has "air cell" type of construction for lightness and strength

Described as easy to use, carry and handle, the Featherweight Drawing Board is said to be extremely light because of its honeycomb or air cell construction—credited to wood panel research by an aircraft manufacturer at the request of the armed services. Of plywood, its combination of top and bottom panels, framework and honeycomb with wood grain running in different directions, is said to provide the strongest panel design possible. All



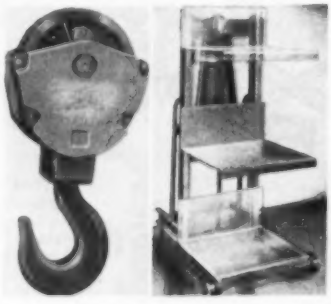
elements are bonded into a permanent unit with waterproof glue and the entire board dipped in a waterproofing agent to seal in and preserve the honeycomb construction.

Board is made in sizes from 12 by 17 in. to 31 by 42 in. Optional extra features are a straight-edge gear rack aligner; transparent, plastic removable straight edges, and a water-resistant vinyl-coated fabric carrying case. Cal-Pan Corp.

9—CRANE BLOCK

Low head type, in capacities from 10 to 50 t for all hook work

The Lo-Head Crane Block, with shorter over-all length, is designed to permit 1½ to 2 ft higher lifts without lengthening the boom. The forged hook operates on Timken tapered roller bearings and the cast steel sheaves are equipped with Hyatt Hi-Load bearings. Lubrication is said to be needed only once each 2000 hr. Alemite fittings are provided for standard grease gun use. American Hoist and Derrick Co.



10—STACKING UNIT

Of 1000-lb capacity, it is designed to lock automatically

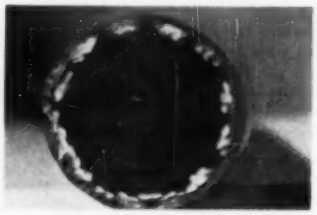
Of fabricated construction throughout, this stacker utilizes company's Portelvator lifting principle. Maximum height of platform surface from floor is 58 in.; minimum, 6 in. Platform automatically locks wherever it is stopped, according to manufacturer, and cannot slip or settle under load.

Platform movement is accomplished through hand crank, roller chain, meshing bevel gears and screw. This method is said to give platform extra rigidity and provide operator with greater safety. Provision is made for rapid platform movement under light loads, it is reported, and stacker is equipped with pressure grease fittings for low maintenance. Platform is 26 by 24 in. Overall height is 70 in., width 32 in., and length 42 in. Weight is 328 lb. Finish is green. The Hamilton Tool Co.

11—BRAIDED AIR HOSE

Long length, for use as air line in spraying equipment

This hose is described as light and flexible. It is made with a red cover of tough, age-resisting stock with a smooth mold finish said to reduce the tendency to accumulate paint and dirt. It has strong cotton reinforcement and a special air hose tube from a balanced construction recommended as suitable for working pressures up to 150 lb.

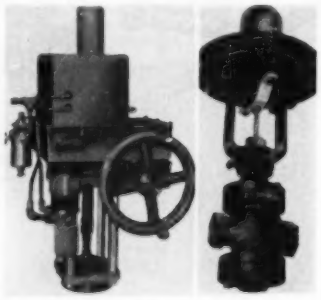


The one-braided type is made in three sizes: ¼ in. ($\frac{21}{64}$ OD); $\frac{5}{16}$ in. ($\frac{5}{8}$ in. OD), and $\frac{3}{8}$ in. ($\frac{1}{16}$ OD). The two-braid is in $\frac{5}{16}$ in. size ($\frac{41}{64}$ OD). The B. F. Goodrich Co.

12—PNEUMATIC OPERATOR

For use on valves, dampers and other throttling control devices

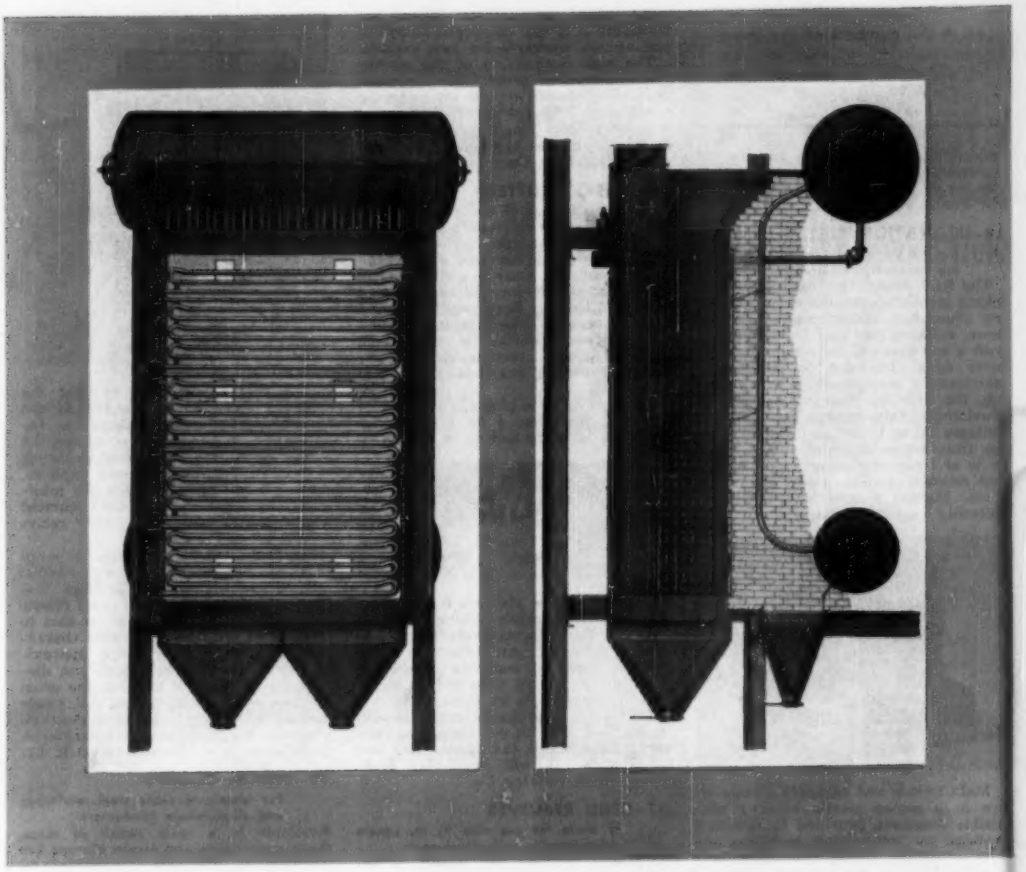
The Rotomotor uses a reversible pneumatic motor and gear driven screw stem to combine the features of a self-locking stem, simple continuously connected handwheel, extreme sensitivity and small compact size. Other features emphasized for this pneumatic power operator are accurate positioning to within 1/500th part of stem travel; sensitivity to instrument changes as low as 0.025 psi; high stability; stem loads up to 10,000 lb; stem travel up to 20 in., and stem speeds up to 12 in. per min. Conoflow Corp.



13—CONTROL VALVE

Is air operated and engineered for quick reversibility

In a few minutes time and without special tools, the Stabilflo Valve can be changed from "air to open" to "air to close" or vice versa, according to manufacturer, and it is not necessary to remove valve from its installation or to shut down the controlled flow. To reverse the action of the valve motor it is only necessary to remove housing assembly, rotate it a quarter turn, and



THE ERIE CITY ECONOMIZER

In this Erie City continuous loop, forced circulation Economizer, feed water is forced into the lower left header, travels thru sectional loops upward and is collected in the discharge header at the upper right. Flue Gas enters the top of the Economizer and travels downward, counter to the flow of water. The resulting rise in the temperature of the entering feed water and the corresponding reduction in gas exit temperature increases the overall efficiency of the generator. All pressure parts are supported with suitable clearance for expansion. Headers are firmly attached and serve as anchor points. Each element is free to expand or contract to meet its individual temperature requirements. Intermediate headers are provided to permit making the elements with a moderate number of short standard loops. This reduces the number of spares required and facilitates replacement.

For a detailed description of this and all other unit parts of our Erie City Steam Generator request Bulletin SB-30, a 40 page catalog.

COMPLETE STEAM POWER PLANT EQUIPMENT

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Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

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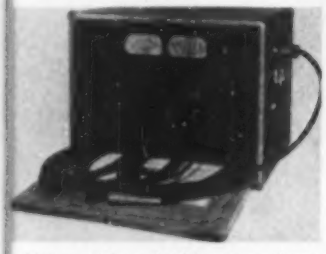
replace it. This is said to require the removal and replacing of four bolts and may be done with an ordinary wrench. The Foxboro Co.

14—INSULATION TESTER

For use on cables, transformers, rotating machinery, condensers

The RLF Model 184C is designed for taking insulation resistance and dielectric absorption measurements. Breakdown voltages can also be determined with a minimum of burning, manufacturer adds. Intended for preventive maintenance and general purpose testing, the unit has four voltage ranges providing continuously variable d-c voltages up to 10 kv. A constant voltage transformer regulates voltage within ½ of 1 per cent to provide constant and reliable readings under all conditions. Manual control is provided for selecting output voltages.



Main switch and calibrating resistors are in a sealed plastic housing with visible dessicant, provided to eliminate leakage by minimizing moisture and film formation. Safety features include a relay designed for automatic removal of dangerous capacitance charges remaining after test. Hardwood cabinet insulates interior from grounds, company points out, and provision is made for remote control of switch. The microammeter is protected against overload by a neon lamp that also indicates breakdown of test specimen, it is stated, and over-voltage from careless control of variac is prevented by limiting resistors. Radio Frequency Laboratories, Inc.

15—SILICA MORTAR

Is said to offer exceptional workability and refractoriness

Grefco Silbrik Bond is for use in construction with silica brick and for repairs to silica brick construction, particularly that in open hearth and electric furnaces and in glass tanks. A carefully ground mortar, it is prepared by washing top quality sand until all clay and other impurities are removed, company explains, adding that this gives the mortar an extremely low alumina content.

The bonding agent used in this mortar doesn't deteriorate its refractory properties, it is stated, because it is a colloidal material which at high temperatures fuses to form a high refractory bond between the silica particles. The water retention of Silbrik Bond is also described as high, and its texture, when mixed, as uniform. Mixed for troweling it is said to spread smoothly and remain workable for long periods.

The high workability of the mortar is considered of great value in work demanding speedy repairs under trying conditions. Prepared especially for use with silica brick, this mortar should not be used with other types of brick. General Refractories Co.

16—GASKET CUTTER

Is hand operated and combines functions of several tools

A cutting tool designed to do the work of a circle cutter, straight edge, compass, scorer, and knife in a single manually operated device will be marketed soon. Called the Spearhead Cutter it will cut accurate-size gaskets from any pliable sheet materials in round, odd, straight, square, rectangular, oval or irregular shapes, manufacturer announces.

Made of durable phenolic plastic and weighing less than 4 oz, it is 4¼ in. long, 1¼ in. wide and ¾ in. high. An

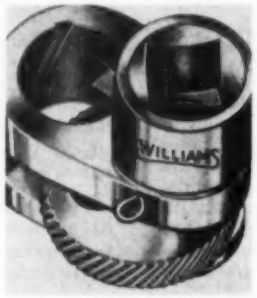
exclusive feature claimed for it is its "ironing" action while cutting, desirable in preventing thin materials from buckling or crinkling. An indication of the cutter's precision, company points out, is its ability to cut accurately a ¼ in. hole in material ⅛ in. thick.

Cutter comes packaged, complete with instruction, in a kit containing the cutter, cutting board, two blades, and two pivot pins. It will retail for $7.50. Zimmerman Packing Co.

17—STUD REMOVER

Is made for use with ½ in. square drive handles and attachments

This stud remover, No. S-60B, is described as equally efficient for removing or setting studs. An eccentrically mounted roller with deep milled edge



is used to provide a non-slip gripping surface which is non-burring. Stud capacity, ⅛ to ¾ in. dia. Made from selected alloy steel, heat-treated and chrome-plated. J. H. Williams & Co.

18—OVERCURRENT RELAY

For distribution feeders, has extreme inverse characteristics

This is described as an overcurrent relay which provides adequate fault protection for most distribution feeders and picks up loads after outages of

sufficient duration have brought the loads of automatic devices onto the lines. Usually when a feeder is re-energized after an extended outage, the accumulation of loads causes an inrush current to flow. As company explains, this, in many cases, exceeds the minimum value of short circuit current which the feeder overcurrent relays should be set to clear.

The indicated solution was believed to be an overcurrent relay with a much more inverse characteristic than that of the so-called "very inverse" relays. Such a relay, Type IAC-27, is said to have an extremely inverse time characteristic curve with a shape approximating those of power fuses and distribution cutouts. It also has the usual features of time dial, tapped coil, single contact with target-seal-in device and provision for instantaneous attachment. Switchgear Div., General Electric Co.

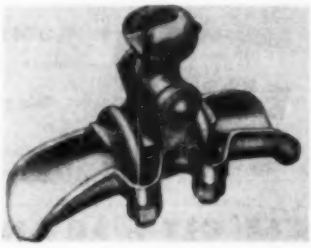
19—STRAIN CLAMPS

For aluminum-cable-steel-reinforced and all-aluminum conductors

Available in a wide range of sizes, these suspension and strain clamps are intended to eliminate hysteresis and eddy current power losses on high-current transmission lines. According to manufacturer, they feature a non-magnetic body that breaks magnetic path around conductor so power losses are negligible, even on heavily loaded lines.

Clamp bodies are drop forged from high strength aluminum alloy and heat treated. They are said to offer superior strength and resistance to shock and fatigue without excessive mass and weight; uniformity and refinement of internal structure; long service; close dimentional fidelity and excellent finish and appearance.

Clamping keepers and machined connectors on the clamps are drop-forged steel, with connecting pins, clamping bolts, nuts and lock washers also of



MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs

90° ELBOWS

REDUCING 90° ELBOWS

45° ELBOWS

LAP-JOINT STUB ENDS

REDUCERS

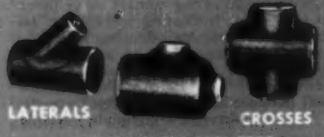
CAPS

SADDLES

SLEEVES

RETURN BENDS

TEES


LATERALS

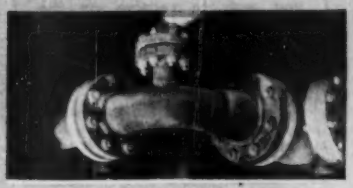
CROSSES

REDUCING-ON-RUN TEES

SHAPED NIPPLES

FLANGES

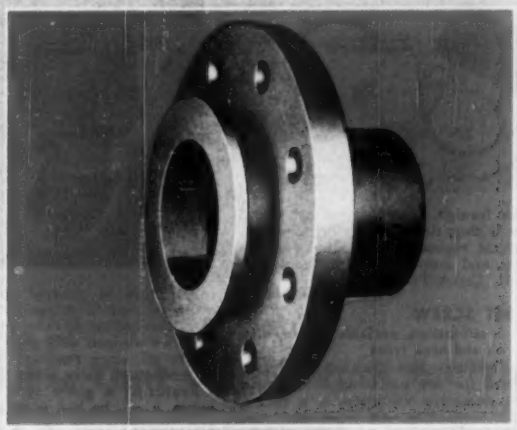
IN WELDED PIPING SYSTEMS



SAVE TIME and MONEY on EQUIPMENT CONNECTIONS

by using MIDWEST

LAP JOINT STUB ENDS



Substantial savings of time and money result if Midwest Lap Joint Stub Ends are used when making connections to valves, equipment or other flanged outlets in welded piping systems. They have important advantages over flanges welded to the pipe.

The swivel flange makes it unnecessary to line up the bolt holes before welding. Setting up is quick and simple because no special clamps or jigs are required to hold the face of the flange absolutely perpendicular to the axis of the pipe. Field crews report as high as 25% saving in erection time for making up a joint using Midwest Lap Joint Stub Ends in comparison with rigidly fixed flanges.

Midwest Welding Fittings improve piping—save money. Get in touch with the distributor near you.

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***Sales Offices:* New York (7), 30 Church St.**
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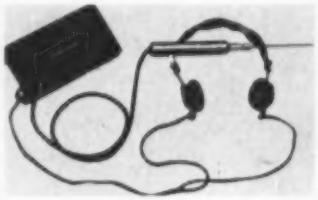
steel construction. All ferrous parts are hot-dip galvanized. The rated ultimate strengths of the clamps are described as more than adequate for use on conductor sizes accommodated. A wide range of sizes is available.

The clamps are said to reduce the effects of conductor vibration by means of a light-weight, short connecting length and smooth, clamp seats with ample cable-supporting length and snubbing radii. Brewer-Titchener Corp.

20—SOUND PROBE

Is electronically controlled to provide extreme sensitivity

This new device, according to manufacturer, localizes sound electronically, bringing it to a focal point and tracing it accurately to its source. Amplification of the sound is said to immediately reveal its true character, whether normal or foreign. The electronical sound probe is thus described as bringing out a natural reproduction of noise at its source, and amplifying it without distortion. Como-Tex Co.

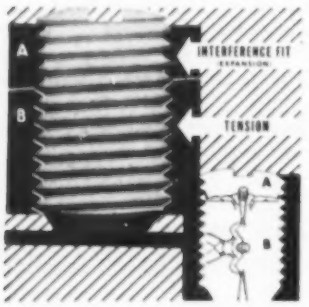


21—SET SCREW

Is self-locking, available in many metals and head types

The Zip-Grip Self-Locking Screw is designed for set screw applications in which excessive vibration is a factor, and for regulating and adjustment use in which instantaneous locking at a precise point is desired.

Zip-Grip is described as the first set screw to have triple locking action by a combination of interference fit, tension and locking of screw against shaft or other part. The lower part of the screw which enters the hole first has a standard thread; the upper section has a larger pitch diameter of the thread section which is intended to create an interference fit or expansion effect against the thread flanks. This is said to result in a tension or opposed-force action, causing thread section of upper part to be drawn downward and that of lower part to be drawn upward in direction of screw's locking action against shaft. Set Screw & Mfg. Co.

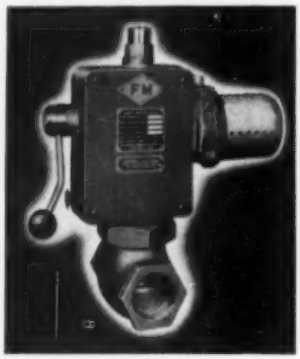


22—SAFETY SHUTOFF VALVE

Is intended to protect industrial furnaces against explosion risk

The Series 21 Safety Shutoff Valve is designed to provide protection against accumulations of gaseous or liquid fuels in the event of a power failure by stopping the flow of gas or liquid instantly when current to its solenoid is interrupted. When power is restored, company explains, the valve remains closed until trouble is corrected and valve is reset manually.

Any number of switches wired in series can protect installation against explosion resulting from failure of air pressure, gas or oil pressure, it is said,



in addition to general power failure, or valve may be tripped closed manually. According to company, the valve can't be wedged or propped open with power off, since resetting handle is independent of valve stem.

Featuring a globe type, soft-seating valve, it can be had with all iron body and internals for use with corrosive gases or liquids and with chain reset wheels for overhead mounting, and with auxiliary switches for independently powered alarm systems. Available in sizes from ¾ in. through 6 in. equipped with solenoids of 110, 220, 440 v and 60, 50, and 25 cycles. The North American Mfg. Co.

23—PIPE THREADER

Is portable unit built for handling pipe up to 6 in. dia

Designed to fit in the average tool box, Porta-Drive weighs only 14 lb, and it is said that one man operating it can thread up to 6-in. pipe in any position —horizontal, vertical or on an angle. Actually a 20 to 1 gear reduction unit, Porta-Drive is driven by any ½ hp, heavy-duty electric drill and attaches to any standard set of dies by adaptor-yokes. An aluminum casing houses a bull gear and cold rolled spur gears, all sealed in grease.

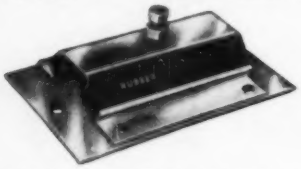
Porta-Drive is designed to thread pipe easily in close quarters such as excavations, corners and near walls. It is not necesary to remove broken pipe when threading it with Porta-Drive. After threading is completed, insertion

of the drill head into a "reverse" drive socket allows removal of the die. Muncie Gear Works, Inc.

24—VIBRATION ISOLATOR

Is drilled, tapped, ready for use, comes in lengths up to 30 in.

Finnflex SP-9 is described as easily available to all types of machinery and equipment. It consists of a steel channel floating in rubber between two steel angles, which in turn are welded to a steel plate for bolting down. Correct angularity between steel and bonded rubber is said to enable isolator to



approximate the "flat" spot on a stress-strain curve of relative slope. Resonance is said to be avoided.

The SP-9 mounts usually provide for a specific load varying from 40 to 3000 lb each, and come in four rubber stiffnesses for loads of 40, 50, 70 and 105 lb per inch of length at ¼ in. deflection. Finn & Co.

25—VARIABLE SPEED DRIVE

Has new hydraulic control for automatic speed changing

With this new control on the Motodrive it is said to be possible to automatically control tension, velocity, pressure, temperature, liquid level of materials in process and to synchronize operating speeds of machines in production line or of parts of the same machine. The actuating force is secured by connecting control valve lever to any speed indicating mechanism on the driven machine—floating roll, follower roll, temperature or pressure indicator, float or moving parts. It is pointed out that even slight pressure will produce changes in output speeds.

The Motodrive is a complete variable

5 LINES OF DEFENSE That Go to Work for You

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speed drive which combines motor, speed changing mechanism and gear reducer in one unit. The control consists of a self-contained hydraulic power plant and simple rotary valve, piston and cylinder in a case, mounted on the Motodrive in place of a handwheel.

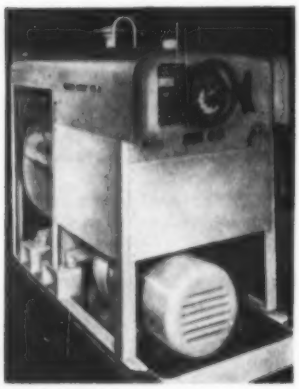
Same control, without hydraulic power plant, is available for pneumatic operation. In this application, compressed air from any available source is connected directly to rotary valve. Compressed air takes the place of oil pressure as the activating medium. Both hydraulic and pneumatic control are available on Nos. 4000 to 7000 Motodrives and may be applied to units in service. Reeves Pulley Co.

26—ARC WELDER

Is 200 amp unit with compact generator and air cooled engine

The 200 amp Hornet Special Arc Welder combines company's 36A generator with a four-cylinder, 31 hp Wisconsin engine. The generator, with welding range from 40 amp at 20 v to 250 amp at 40 v, is built as a two-bearing unit. Its closely spaced bearings are intended to provide maximum load safety, and double shields are used to keep out dirt and hold grease in. The control wheel mounted on panel shows current markings—obtained by setting pointer. This hand wheel has five positions.

Generator has excitation of main field supplied by an auxiliary brush. This is said to insure instant recovery voltage over short circuit. Welding terminals are described as readily accessible and adequately spaced to prevent accidental shorting of welding cable lugs.



The air cooled engine has magneto ignition with impulse starting, and is hand cranked. Entire welding unit is 58½ in. long, 25⅝ in. wide and 47 in. high; it weighs 825 lb. Comes equipped with full length canopy and a lifting eye is provided on top. Optional equipment includes two-wheel, trailer type running gear with pneumatic tires, 38 in. drawbar. Air Reduction Sales Co.

27—STRAIGHTLINE SPLICE

For aluminum-over-steel conductors, requires no tools for installation

This splice is available for 7/1 and 6/1 strand in both No. 2 and No. 4 wire sizes. The outer tube is hardened alloy designed to provide over-all resistance less than the same length of conductor. Assembly to steel core conductor is said to be fast and positive. The steel core is bared for 3 in.; core wire passes through hole in spring cup; aluminum

strand does not enter nose of splice until steel core is through washer hole; aluminum then follows to shoulder of steel core jaw section. Manufacturer claims this assures proper location of core for full core-gripping area of jaws.

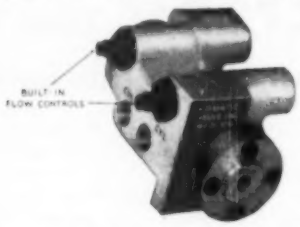
After the aluminum strand enters the splice it is inserted until it stops against the smaller steel core jaw area. Applied tension sets jaws on steel core and on aluminum strand. Splices are individually packed with neutral grease, in double cellophane envelopes. Reliable Electric Co.

28—HYDRAULIC VALVE

Is compact master air and low pressure type with built-in-meter

The MV-4-375 Valve has built-in full capacity flow control meters of the venturi type. The one-piece balanced spool uses aircraft packing eliminating metal-to-metal contact between wearing parts. Replacing the "O ring" packing renews the valve, company states, adding that this design permits full line volume without loss of pressure and operation is not affected by line pressure variation.

Valve can be close-coupled to the cylinder, to increase speed of opera-

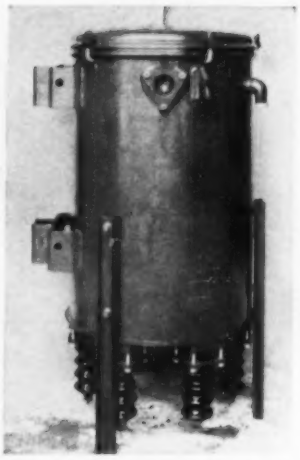


tion and can be used in conjunction with pilot valves to provide automatic and semi-automatic operations, sequence of operation and also remote control paneling. Offered in standard pipe sizes: ¼, ⅜, ½, ¾ in. Airmatic Valve, Inc.

29—CAPACITOR SWITCH

Is oil immersed, electrically operated, built for outdoor use

Rated 15,000 v, 100 amp continuous, 3-phase, the B-1 Capacitor Switch is designed to enable users to supply additional kilovars more economically by means of capacitors. According to company, the new switch is intended to encourage capacitor installations on high voltage circuits and supplant more expensive switching devices. Primarily



intended for pole mounting, it can be supplied as a component part of housed capacitor equipments if desired and is capable of switching its continuous current (100 amp) at 15,000 v. Transformer and Allied Products Divs., General Electric Co.

30—RECTIFIER ELEMENTS

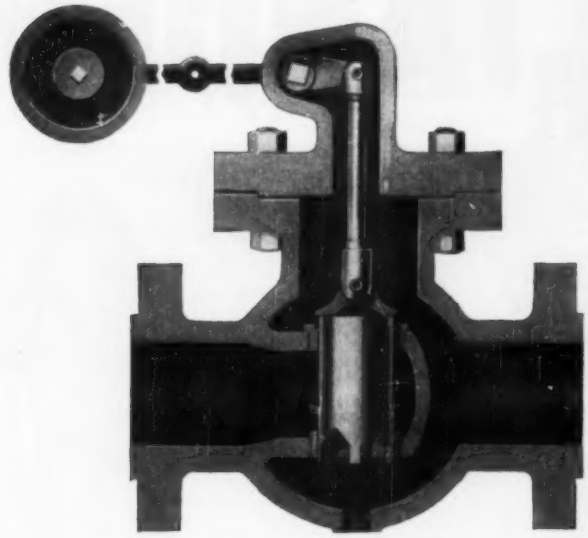
High current, dual type are extra large, for medium voltage use

Said to be the largest known dual selenium rectifier elements, these measure 7¼ by 12¾ in. Each dual element actually consists of two of company's largest size plates strapped in parallel and rated in a three-phase bridge circuit at 34 amp for continuous duty self-cooling, 85 amp for continuous duty fan cooling, assembled in a three-phase heavy duty 10 kw rectifier stack rated at 1500 for such applications as magnetic inspection.

Stacks are designed on the basis of 16 kw per cu ft and are provided with an interlocked assembly to prevent lug misalignment and plate rotation. They are covered with a multiple dipped black coating for improved heat radiation and protection against adverse atmospheric conditions. Operating efficiencies of 85 per cent can be obtained, manufacturer states.

These dual rectifier assemblies are especially recommended for high current intermittent duty, medium voltage (55 v and below) applications and for eliminating large storage battery banks. International Rectifier Corp.

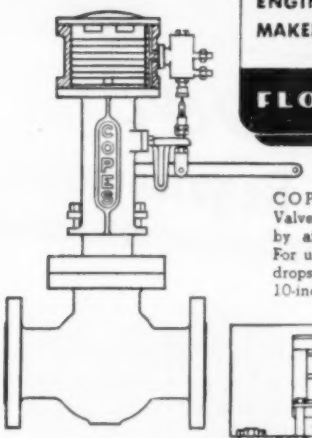
COPES BALANCED VALVES



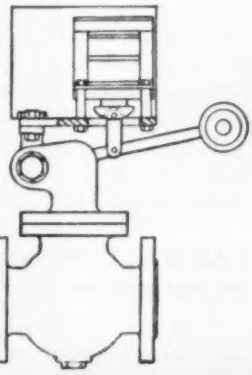
A valve may be statically balanced while at rest, yet be so badly unbalanced dynamically—when handling flows under pressure—that inaccurate response to the actuating element causes a "hunting" action which makes impossible the desired precision of control. In COPES Valves, unbalanced forces are held within narrow limits over the entire operating range. This is why so many have been purchased *at a premium,* where control must be precise with actuation by float, solenoid or other element. Sizes: ¾-inch and up. When writing for data, give complete information on your operating needs.

ENGINEERED BY THE MAKERS OF COPES

FLOWMATIC



COPES Type SLH Valve, relay operated by air, oil or water. For unlimited pressure drops. Sizes: 1½- to 10-inch.



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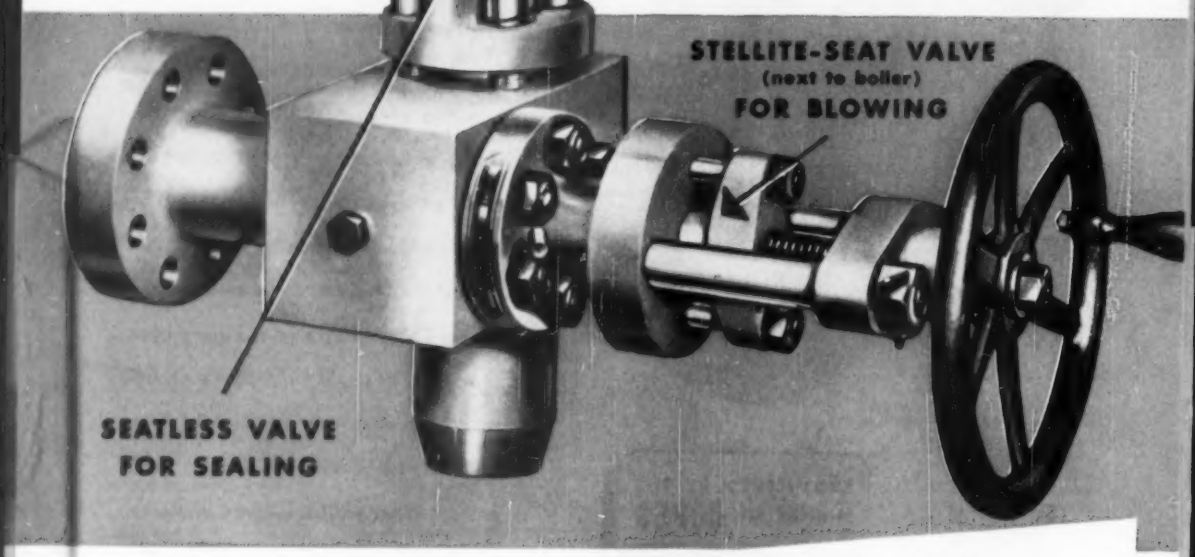

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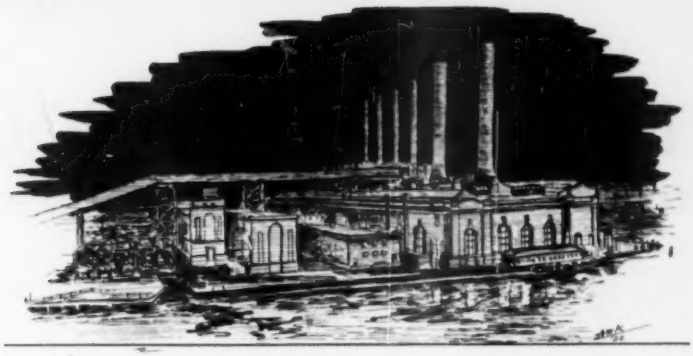
YARWAY **BLOW-OFF VALVES**

At the TURN of the HALF CENTURY

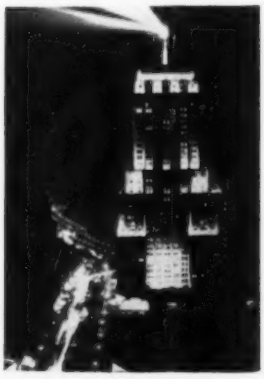


ALL was quiet in the electrical control room at Fisk Station as the last few minutes of the Old Year ticked away; the roar of the great turbines could not penetrate the sound-proof, air-conditioned control center. The system load indicator remained steady at ***two million*** kilowatts and the Fisk Station indicator steady at about 370,000 kilowatts, the station's share of the load.

Outside, across the nation, more than a billion lights shone on gay merrymakers, and on some not so gay. From New York to San Francisco millions of people were gathered in homes, in churches, in night clubs and restaurants, in bars and taverns—in cities, towns, and villages on farms—to see the Old Year out and the New Year in.

To the operators at Fisk Station, as in other generating stations throughout the land, the minutes which marked the passing of the first half of the Twentieth Century were uneventful. This was their job. If, for the moment, they thought of the merrymaking outside, they accepted the fact that it was their job to keep the turbines running. They were the power behind the billion lights outside.

The watch had changed an hour before, at 11 o'clock. There had been some good natured bantering on the part of the incoming watch about the lucky stiffs who could go out and celebrate. The off-shift men thought about careless car drivers, worse on New Year's Eve, and hoped they wouldn't have trouble with them, as they drove home. One operator hoped there would be no emergencies that night—he felt a little superstitious about trouble the first night of the year. The older men were less concerned about having to be on duty than some of the young bloods, but there was no griping.



Outside, across the nation more than a billion lights shone on gay merrymakers, and on some not so gay, gathered to see the Old Year out and the New Year in

A few minutes before twelve o'clock, a handful of men spontaneously gathered in the Watch Engineer's office for a cup of coffee and to wish each other a Happy New Year. In other parts of the great station other operators similarly exchanged greetings. One or two of the men called their wives on the telephone at the midnight hour. It made the women feel better, they explained.

The great turbines roared on, however. In the long, white-tiled turbine room two of the largest generators in the world ground out some 300,000 kilowatt-hours every hour and in the boiler room two ultra-modern steam generators greedily consumed fifty tons of coal each in their cyclone furnaces. With its 473,000 kilowatts of capacity, Fisk Station, today, is the largest of the ten stations on the Commonwealth Edison system.

These white-tiled walls at Fisk, however, have seen other days. In a sense, this station represents a half century of power development in this country. It was the first all-steam-turbine station in America, and the first 5000 kilowatt vertical turbine installed at Fisk in 1903, stands today, in the yard of the General Electric Works at Schenectady as a monument to commemorate the beginning of the large turbine industry. Side by side with the newest 150,000 kilowatt unit still stand three of the old 12,000 kilowatt vertical units built in 1908.

Few of the operators on duty as the second half of the century was ushered in could remember as far back as 1903 but the equipment in the old station tells the story more eloquently than reminiscences of a few old timers whose memory grows dim. We spent a few minutes in the frequency-changer room. In the quiet of the night it was vast and dim, like a great cavern, but here were two giant frequency changers exchanging some 80,000 kilowatts between the 25 and 60 cycle systems. The nameplate on each of the motors read ***54,500 horsepower.*** Installed many years ago, they are still among the largest motors in the world. In the turbine room, beside the old vertical units is an old Parson's unit, built in England years ago, but still running.

The days of these old machines are numbered, however, and as the last seconds of the old year ticked away, evidence of a new era in power development was reflected in the cyclone furnaces and 150,000 kilowatt machines at Fisk Station. Where will the next half of the century take us in the field of power generation? No one can tell, neither the operators on duty at midnight on New Year's Eve, nor we, editors, who try to peer into the strange future; but if the development represented by Fisk Station during the last fifty years can be taken as a criterion, we are bound to go very far indeed—farther than any of us have the power to imagine.

THE POWER INDUSTRY—

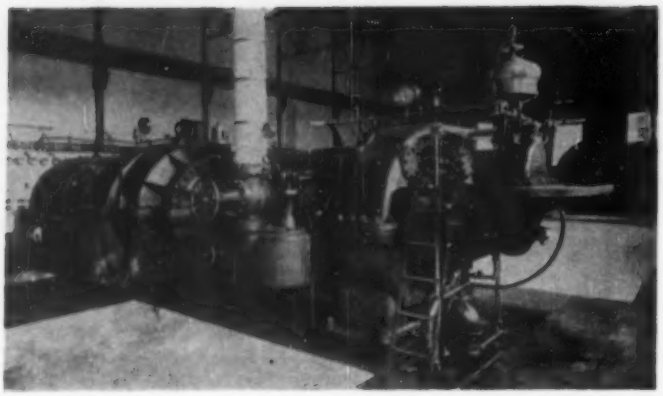
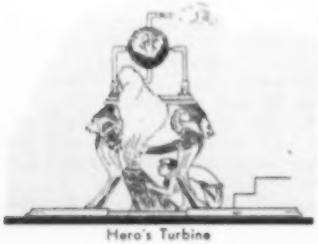


Fig. 1. A photograph of the first turbine for central station use in the United States. This was the 2000-kw Westinghouse unit installed in the plant of the Hartford Electric Light Co. in 1900. It was a 1200 rpm condensing turbine, far exceeding in capacity any unit previously built. This machine ran for eight years

AS THE WORLD MOVES into the second half of the twentieth century the advent of nuclear energy or atomic power as it is popularly known gives promise of changes so vast, so inconceivably beyond anything we can even imagine today that it would be foolish to try to predict what the power industry will be like in the year 2000. Make no mistake about this; do not be misled by economics or so-called engineering considerations by so-called experts today. The nucleus of the atom is not amenable to economics. As pointed out in a recent issue of *Nucleonics*, an accountant can't see an atom and if he could he probably wouldn't know what he was looking at. For this reason, all estimates of the probable cost of developing atomic energy are relatively worthless. Such estimates only show up the circumscribed kind of thinking which people—engineers as well as accountants—indulge it. As *Nucleonics* points out, "only a scientist can tame an atom, and almost no one can tame a scientist, except perhaps his wife. Trying to reduce such a situation to generally accepted accounting principles consistently applied is both elusive and illusory."



Hero's Turbine

In the use of nuclear energy we have a gain over present day fuels of three million to one. No matter what the engineering difficulties, no matter how diffused the supply of fissionable materials may be on earth, nuclear power will be put to use during the next half century. It is fortunate that nuclear energy can be used as a war weapon because the development of weapons, like the atom, is not subject to the laws of economics, and the intensive research that is going on under the weapon program is enormously accelerating the development of atomic power for peacetime use.

Fifty years ago, in the year 1900, the first turbine-generator for central station service went into operation in the plant of the Hartford Electric Light Co. A picture of this unit is shown on this page. It was a 2000-kw, 1200 rpm condensing turbine driving a d-c generator through reduction gears. As will be seen from the photograph, it was quite modern in appearance. Charles A. Parsons had developed the turbine in England and as soon as George Westinghouse heard of Parson's success he investigated and in 1895 Westinghouse obtained the exclusive American rights for the Parson's type steam turbine. After building several small units—one 400-kw unit—the Hartford unit was built in 1900.

First 500-Kw at Fisk

The General Electric Co., in the meantime developed a type of turbine based on the patents of Curtis. At first, the vertical type was exclusively the standard in this type of turbine. Outstanding among the names associated with the early days of the utility industry and the steam turbine is the name of Samuel Insull. Despite the later notoriety which surrounded this man when the lust for power and money overruled his earlier good judgment, Samuel Insull deserves considerable credit for his untiring efforts in the development of the utility industry. It was Insull's confidence in the advantage of the turbine that led him, in 1903 to install the first 5000-kw turbine generator at the old Fisk Street Station in Chicago. This was by far the largest turbine unit ever constructed and there was some apprehension concerning its feasibility. A picture of this unit is shown in Fig. 3. It was a vertical unit which operated successfully for many years. Then, it was moved back to the General Electric Co. works at Schenectady, where it was made, to stand as a monument to commemorate the beginning of the turbine industry.

There is a great difference between these early turbines, the one at Hartford, the 5000-kw unit at Fisk, and the modern 100,000 and 150,000-kw turbine generating units of today—between them lies the growth and development of practically the whole of the electric power industry as we know it today. Yet, if history is any criterion, we can expect far greater changes in the power industry in the next 50 years. This would probably be true even without atomic energy but with it, the changes are bound to be revolutionary. With the development of the breeder type of nuclear reactor the entire problem of fuel supply and transportation will vanish. Instead of having to transport hundreds of millions of tons of coal and

Past, Present, and Future

oil over long distances, it may become possible to deliver the nation's annual nuclear fuel supply in a single good size truck. At the present time, of course, noboby outside of the top members of the Atomic Energy Commission know how much fissionable material can be made with our present production facilities. Niels Bohr was attributed to have said that at the close of the war the Oak Ridge plant was making 6 lb of U-235 a day by the gaseous diffusion process. Since then we have considerably added to the capacity of the diffusion plant, and, of course, the Hanford facilities have also been extended.

Cost of Uranium

Even now, as reported by Dr. John R. Dunning at the meeting of the American Association for the Advancement of Science in New York on December 26, the cost of producing fissionable uranium is somewhere between $10,000 and $25,000 a pound. Averaging these two extremes would give us uranium at a cost equivalent to less than $10.00 per ton for coal. Many present-day steam stations, of course, pay only a little over $5.00 per ton for coal.

As Dr. Dunning said, "uranium fission converts only one part in a thousand of mass into energy, so we certainly have plenty of room for some faith in the future and some new ideas and discoveries.

During the first fifty years of the twentieth century, we have attained in this country the world's highest standard of living, due largely to our great and universal use of electricity. In 1949 the use of electrical energy by residential customers reached an all time high in the United States with an annual consumption of 1685 kilowatthours per customers. Only 10 years ago the average annual consumption per customer was 897 kilowatthours. At the end of the year 1949, there was installed in this country a total of 63,500,000 kw of generating capacity. This included plants of all business-managed companies as well as federal, municipal and REA plants.

The leadership of the United States in the production of electricity among the nations of the world is indicated in the accompanying table. With a total annual production of 336,808,000,000 kwh, the United States produces 44.4 per cent of the world's production. This figure is even more significant when we compare it with population. With less than 7 per cent of the world's population, the United States produces (this was in 1948) over 44 per cent of the world's electricity. This was about 5½ times as much electricity as Russia, the country generating the next greatest amount, was able to produce.

At the beginning of the century many generating plants used as much as ten pounds of coal per kilowatt hour and the best stations used around six pounds. (Edison's *Jumbo* units which required *only* 10 lb per kwh were a great improvement over earlier arc-lighting plants which used 30 lb of coal per kwh.) Today, the national average is 1.2 lb of coal per kwh and the most efficient plant requires less than ¾ of a pound of coal per kwh.

For the long term future, these gains will serve as the springboard to much greater progress. Future years will witness great development of the gas turbine. The gas turbine has been in process of development for some 25-years but only this year was the first gas turbine installed in a central station in this country. Of course, they have been used in Europe for well over ten years. The great advances in the art of metallurgy, however, have given renewed impetus to gas turbine development during the last four years and from now on, an increasing number of gas turbines will be installed for power production. The development of the coal-burning gas turbine is well

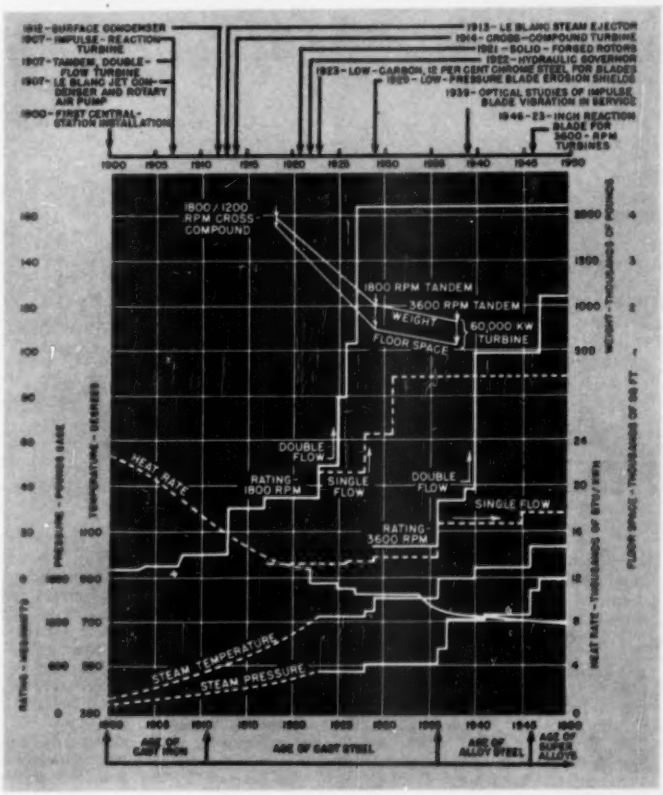

1912 - SURFACE CONDENSER
1907 - IMPULSE - REACTION TURBINE
1907 - TANDEM, DOUBLE-FLOW TURBINE
1907 - LE BLANC JET CONDENSER AND ROTARY AIR PUMP
1900 - FIRST CENTRAL-STATION INSTALLATIONS
1913 - LE BLANC STEAM EJECTOR
1914 - CROSS-COMPOUND TURBINE
1921 - SOLID - FORGED ROTORS
1922 - HYDRAULIC GOVERNOR
1923 - LOW-CARBON, 12 PER CENT CHROME STEEL FOR BLADES
1929 - LOW-PRESSURE BLADE EROSION SHIELDS
1939 - OPTICAL STUDIES OF IMPULSE BLADE VIBRATION IN SERVICE
1946-53 - INCH REACTION BLADE FOR 3600 - RPM TURBINES
1800/1200 RPM CROSS-COMPOUND
1800 RPM TANDEM
3600 RPM TANDEM
WEIGHT
FLOOR SPACE
60,000 KW TURBINE
DOUBLE FLOW
RATING - 1800 RPM
SINGLE FLOW
DOUBLE FLOW
SINGLE FLOW
RATING - 3600 RPM
HEAT RATE
STEAM TEMPERATURE
STEAM PRESSURE
PRESSURE - POUNDS GAGE
TEMPERATURE - DEGREES
RATING - THOUSANDS OF KW
WEIGHT - THOUSANDS OF POUNDS
HEAT RATE - THOUSANDS OF BTU/KWH
FLOOR SPACE - THOUSANDS OF SQ FT
AGE OF CAST IRON
AGE OF CAST STEEL
AGE OF ALLOY STEEL
AGE OF SUPER ALLOYS

Fig. 2. Chart showing the development of the steam turbine and the influence of the development of different metals upon its growth. This chart was presented at the Westinghouse Electric Corp. Mid-century Review and Forecast Forum in Pittsburgh, November 10, 1949

Fig. 3. The first 5000-kw steam turbine generating unit installed at the old Fisk Street Station in Chicago in 1902. This was the largest unit ever built at that time and Fisk Station was the first all steam turbine electric generating plant built in this country. Curiously enough, Fisk Station today, has installed in it the largest single-shaft steam turbine unit ever built. This unit is shown in Fig. 4

under way and when a fully practical and successful coal-burning gas turbine is achieved even our highly developed steam turbine will disappear, not completely perhaps but to a marked extent.

Like the gas turbine, the mercury turbine has been a long time in development. Development of the mercury turbine dates back some 30 years and during this time General Electric has spent upwards of 20 million dollars in its development. The first commercial mercury turbine went into operation in 1928 at the Hartford Electric Light Co. This first installation was designed by W. L. R. Emmet then consulting engineer of the General Electric Co. and his assistant L. A. Sheldon and installed under the supervision of H. N. Hackett. The mercury cycle was developed by these pioneers to superimpose or top the then existing low-pressure 250 psig steam cycle. Today, even with the practical maxima of pressure and temperature in steam generating equipment, the mercury cycle still can successfully top such units and increase the overall efficiency. The resulting economies, especially in the higher fuel cost areas, may be sufficient to pay off the additional investment in about three years.

In January 1949—just a year ago—a new mercury boiler and turbine was started in the South Meadow Station of the Hartford Electric Light Co. This replaces the old unit referred to above. The new unit consisting of a 15,000 kw mercury boiler and turbine, produces 33,000 kw net capacity from the mercury turbine and steam produced in the condenser-boiler. This unit is the first of several post-war mercury unit power plants to be placed in service before very long.

WORLD PRODUCTION OF ELECTRICITY—1948

Country	Kilowatthours Produced	Per cent of World Production
United States	336,808,000,000*†	44.4
Russia	60,000,000,000‡	7.9
Canada	46,930,000,000*§	6.2
United Kingdom	46,536,000,000	6.1
Japan	33,624,000,000	4.4
Germany (United States, British, and French zones)	31,320,000,000	4.1
France	27,564,000,000*	3.7
Italy	22,692,000,000	3.0
Sweden	14,268,000,000*	1.9
Norway	12,444,000,000*	1.7
Estimated other countries, including Russian zone in Germany	125,814,000,000	16.6
Total	758,000,000,000	100.0

SOURCE: United Nations Statistical Bulletins, Sept. 1949.

NOTES: * Includes industrial plant production.
† EEI Statistical Bulletin No. 16.
‡ Business Week, Feb. 12, 1949.
§ Industrial plant figures for 1945.

Where the Mercury Turbine Fits

While high thermal efficiencies can be attained by the use of the high-pressure high-temperature steam cycle, the mercury turbine offers attractive features in that its high thermal efficiency can be attained with small plants—plants of 1500 kw and less. Thus, while it is possible with present day high temperature steam plants to attain very high thermal efficiencies in large stations, it is not economically feasible to obtain these same efficiencies with small steam plants. It is here that the mercury type of plant offers great promise.

Thus, both the gas turbine and the mercury turbine can be expected to find increasing application in future decades. The task with the gas turbine in the immediate future is, clearly, to develop it for long continuous operation with gas temperatures beyond 1300 degrees and to obtain information as quickly as possible that will lead to construction of suitable units for temperatures up to 1500 degrees. Such programs are being aggressively pursued. Both the central station field and industry generally have attractive applications for the gas turbine that await its development. There is little doubt that such practical, long-life machines will become a reality and that machines of open-cycle form and in capacities up to, say, 10,000 kw will be built in a few years. Closed cycles offer pos-

Faraday discovering the principle of the electric generator

sibilities of machines several times this rating.

Now, at mid-century, the gas turbine stands about where the steam turbine stood at the beginning of the century. The gas turbine inherits much experience from its cousin. Its further development, for all its obstacles should be rapid and what the next 50 years holds for the gas turbine, like atomic energy, makes interesting speculation.

Development of all three types of prime movers, the steam turbine, the gas turbine, and the mercury-vapor turbine will no doubt continue far into the second half of the twentieth century unless some new type of electric generator, such as, for example, a thermoelectric generator, should be developed. This is true regardless of whether or not nuclear energy comes into use on a large scale. At the present time the only practicable method of developing power from nuclear energy is by utilizing the thermal energy produced as a consequence of nuclear fission in a conventional type of prime mover such as a steam, gas, or mercury turbine. Nuclear energy is thermal energy and unless a way is found whereby this thermal energy can be converted directy into electrical energy, it will be necessary to use prime movers driving electrodynamic generators.

New Forms of Generators

As indicated in the section devoted to electrical engineering in the pages that follow, there is a possibility that a practical thermoelectric generator might be built—a generator that would absorb the heat from a coal or oil fired furnace, or a nuclear reactor, and convert it directly into electical energy. A new type of thermocouple, one made of silicon carbide and carbon has been developed which produces a very much higher electromotive force per degree difference in temperature and this thermocouple offers possibilities in that direction, though there may be reasons which will prevent the development of a practical generator of this kind. Some scheme of this kind would be of inestimable value in abstracting the heat from a nuclear reactor. It appears that the amount of energy that may be released in a nuclear reactor and, hence, the amount of power that may be produced, does not depend upon the size of the reactor as determined by nuclear considerations. Any amount of power from a few watts up to hundreds of thousands of kilowatts may be produced from any size pile provided the energy can be removed from it. In other words the problem in reactor design is mainly one of heat transfer. In the extreme case, the atomic bomb is a nuclear reactor and it is quite clear from even the small amount of information that has been released, that the mass of uranium or plutonium involved in the bomb is of the order of a sphere 3 to 6 in. in diameter.

The great advantage of atomic power over other forms of power lies in the extreme concentration of the *fuel*. In recent years there has been considerable discussion concerning the possibility of utilizing the radiant energy issuing from the sun directly by photosynthesis, or by some other method. True, all our power stems from the sun and each square mile of the earth's surface receives a relatively enormous amount of energy from the sun, but it seems unlikely that a practical method can be developed in the foreseeable future which would convert this radiant energy into useful power without the construction of vast structures covering large areas. Wind power is somewhat in the same category and, so far, the most feasible way of utilizing wind power is by the pumped storage method, that is by having windmills pump water from a low to a high level and then using the potential energy of the stored water in hydroelectric plants. This scheme, however, involves the building of great reservoirs and while other forms of energy are still relatively cheap this method is not likely to find extensive use.

At the present time coal and oil are abundant in many parts of the world and since these are concentrated forms of energy they will be drawn upon until the reserves have been exhausted. In the meantime, nuclear energy offers an almost infinitely more concentrated form of fuel and therein lies its particular charm. A small reactor, no larger than a modern steam boiler may be able to deliver a thousand, perhaps a hundred thousand times as much energy.

Atomic energy, then, is the great new force of the second half of the twentieth century. It offers prospects of revolutionary changes far greater than those which the development of the steam turbine brought in the first half of the century. Our electric power systems no doubt will continue along the present lines of development; our electric transmission and distribution systems will grow and become more effective and efficient. Transmission voltages will increase on our long distance transmission systems, the underground transmission of electrical energy will be developed to a point where it may become possible to do away with overhead transmission as has been the case in telephone systems.

As to the use of electrical energy in this country fifty years from now, it would be foolish to even try to predict. About all we know now, is that in another ten years, by 1960, say, the installed electric generating capacity in the United States will be well over 100 million kilowatts and this assumes no use of atomic energy. After that, atomic energy will probably begin to have its effect.

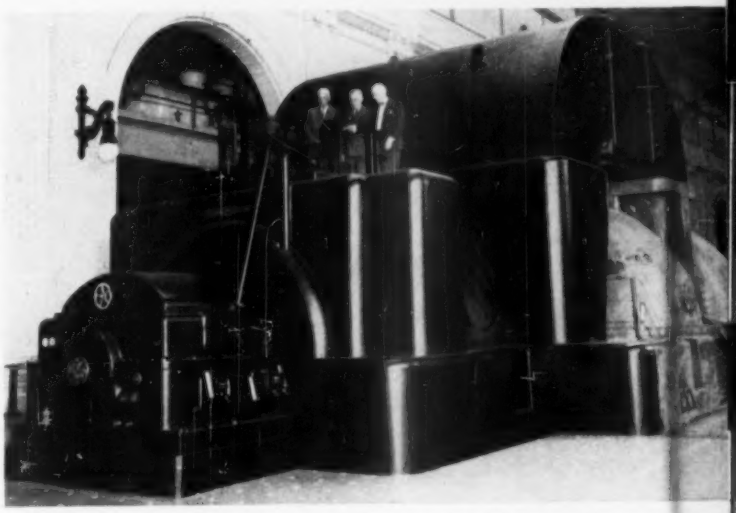


Fig. 4. The 150,000 kw turbo-generator placed in service at Fisk Station of the Commonwealth Edison Co. in Chicago in July 1949. This is one of the largest generating units ever built. It is Unit No. 18 at Fisk and with its installation, Fisk Station attains a capacity of 473,000 kw, making it the largest of the ten generating stations of the Commonwealth Edison system

Power Plants of 1950—How They

Fig. 1. General view of Sewaren Generating Station of Public Service Electric & Gas Co. of New Jersey. First station to go into operation with 1500-psi, 1050-F, straight condensing, single-shaft, 100,000-kw, 3600-rpm turbine generators—three units now operating. A fourth unit is on order, rated at 125,000 kw, 3600 rpm, for 1050 F with reheat to 1000 F. (See PG, July 1949). Boilers semi-outdoor; centralized control for each pair of units

By CHESTER R. EARLE,
Managing Editor,
Power Generation

AT THE BEGINNING of the second half of the 20th century, after a period of the most intense and prolific development, the power industry stands on the threshold of its greatest achievements. Here is what it has to work with:

Fuels—Coal remains, as it has been for the first 50 years, king of fuels, but temporarily the king is having difficulties. Rising labor costs and the uncertainties of supply are causing a trend in both domestic and industrial fuels towards oil and gas.

It is estimated that the recoverable mineral fuel reserves of the United States at present are somewhat as follows:

Coal	Reserves—Jan. 1, 1949	Years Supply (At present consumption rate)
Anthracite	8,000,000,000 tons	136
Low-volatile Bituminous	26,000,000,000	226
High-volatile Bituminous	619,000,000,000 tons	1367
Sub-bituminous	409,000,000,000 tons	
Lignite	470,000,000,000 tons	
Petroleum	26,500,000,000 bbl	13
Oil from Shale	200,000,000,000 bbl	100
Natural Gas	174,000,000,000,000 cu ft	29

New discoveries of oil and gas fields, such as occurred in the 1920's and are occurring today in Western Canada, might change that picture.

More and more oil and gas are being burned as industrial and power plant fuel, for the expanding pipe line systems and transportation methods are making them available in areas not served hitherto. More and more oil is being demanded by the trend toward the Diesel locomotive. Many power plants, designed for burning oil or gas or both as supplementary fuel to coal, are converting or planning to convert to oil or gas as the price differentials narrow and vary.

However, many factors may operate to change the present picture. The coal and oil industries have work under way to produce synthetic gasoline, Diesel oil, by-product chemicals and pipe-line gases from coal. A plant to produce these products from natural gas is being built. Experimental plants for the same purpose have been built by the U. S. Bureau of Mines, which has also developed processes for reclaiming oil from shale.

The fluidization of coal is another development available to us, producing a char for fuel, plus by-products. Underground gasification of coal is being experimented with and it is known that gas can be produced. Electrolysis of coal in the ground has also reported to be possible. Studies are under way to liquefy coal, also to develop more compact gas producers—both of interest in connection with the gas turbine.

New techniques in recovering oil and gas, as well as coal, tend to conserve the supply to some extent.

Instead of consuming about 600,000,000 tons of bituminous coal a year, as at present, we may need over a billion tons a year by 1960 or 1970. Of course, the efficiency of coal burning equipment is being constantly increased, as shown by Fig 6; nevertheless, we shall probably need over 100,000,000 kw of capacity installed in the country by 1960. (This will bring reserve capacity up to about 15 per cent.)

All this will require more coal to be mined; to keep fuel costs down, the present mechanical methods of coal mining must be improved and new ones developed. Coal treated as

Foreshadow Tomorrow's Progress

a raw material may have to drive out coal-by-the-lump and its outmoded "materials-handling" philosophy.

Finally at the end of about 20 or 25 years, the first commercially feasible atomic energy power plants may make their appearance. These will come gradually and will affect the fuel situation but little at first, for their principal use will probably be in places where present fuels are too expensive or require much transport.

Pressures and Temperatures:—Up to the late 20's and early 30's, steam pressures and temperatures were generally in the 400 to 600-psi, 750 F range, although 1,200-psi units had been operated as early as 1924. Improvements in metals for high temperatures have permitted steam temperatures to be raised to the present level of 1050 F but already boiler and turbine designers are talking about the possibilities of steam temperatures as high as 1500 or 1600 F.

Reheat: — Originally the reheat cycle was adopted at temperatures around 750 F to reduce moisture in last stage turbine blades and permit use of higher pressures. It worked out satisfactorily, on the whole. The recent revival of interest in reheat, for stations going into service in 1949, is influenced by increased fuel costs, higher load factors, the more simple one-boiler-per-turbine design now widely used, and several other factors.

Metals:—Use of alloy steels containing such stabilizing materials as molybdenum, chromium, colombium, vanadium and nickel in various combinations has permitted the present use of 1050 F steam temperatures, and in the gas turbine, gas temperatures up to 1500 F.

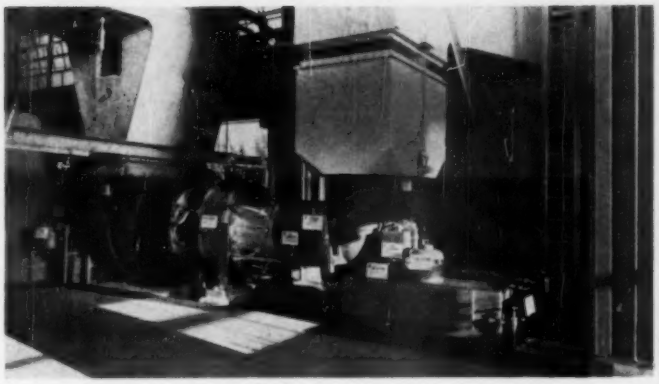


Fig. 2. View of 3500-kw GE stationary gas turbine generator set at Arthur S. Huey Station of Oklahoma Gas & Electric Co. in operation since July, 1949. Unit designed for turbine inlet temperature of 1450 F, develops full load at 1290 F, exhausts at 780 F to recuperator that heats feedwater in steam turbine cycle, thus raising total capacity of station by 7000 kw. (See PG December 1949 issue)

Turbine Generators: — Aside from the use of high pressures and temperatures, modern turbine generators can be built in sizes up to 150,000 kw in single-shaft 1800-rpm machines and up to 100,000 kw and even 125,000 kw for 3600-rpm machines.

Standardization of turbine designs for condensing units of 10,000 to 60,000 kw capacity is being carried out and promises to lead to economies in construction and thus lower generating costs.

Hydrogen cooling of generators is well established, since its first application in 1937. In general, hydrogen pressures of ½ lb are used; by increasing the hydrogen pressure to 2 lb, 15 lb or even 30 lb, capacity of the generator may be increased.

Increased reliability of modern turbine generators is shown by the fact that forced outages have decreased and the once-a-year scheduled shut-downs for inspections have increased in many cases to once in two years or more.

Boilers: — For all industrial or utility application, boilers have been developed to give reliable, continuous service. The present utility boilers—properly called steam generating units when their firing equipment, fans, economizers on heaters and other auxiliaries are included—are beginning to assume a pattern: large, high water cooled furnace, moderate heat release ranging from about 20,000 Btu to 16,000 Btu per cu ft of furnace volume, radiant and convection superheaters and various methods of steam temperature control, steam cleaning devices, economizers, air heaters.

Single steam generating units of over 1,000,000 per hr of steam output are now available for the largest units. Centralized automatic and manual control for such units is imperative; the upper parts of the unit may be 100 ft above the operating floor. From these large units, capacities in various designs range all

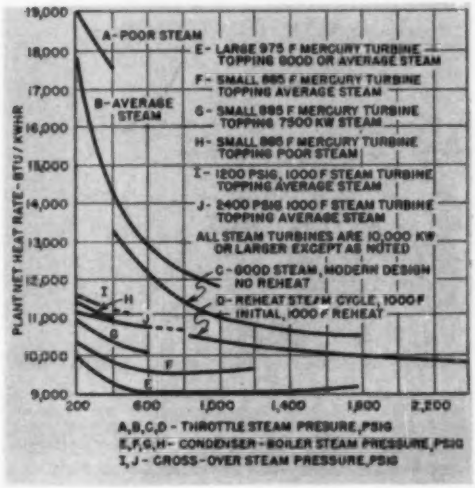

PLANT NET HEAT RATE - BTU / KWHR
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
200
600
1,000
1,400
1,800
2,200
A - POOR STEAM
B - AVERAGE STEAM
E - LARGE 975 F MERCURY TURBINE — TOPPING GOOD OR AVERAGE STEAM
F - SMALL 885 F MERCURY TURBINE TOPPING AVERAGE STEAM
G - SMALL 885 F MERCURY TURBINE TOPPING 7500 KW STEAM
H - SMALL 885 F MERCURY TURBINE TOPPING POOR STEAM
I - 1200 PSIG, 1000 F STEAM TURBINE TOPPING AVERAGE STEAM
J - 2400 PSIG 1000 F STEAM TURBINE TOPPING AVERAGE STEAM
ALL STEAM TURBINES ARE 10,000 KW OR LARGER EXCEPT AS NOTED
C - GOOD STEAM, MODERN DESIGN NO REHEAT
D - REHEAT STEAM CYCLE, 1000 F INITIAL, 1000 F REHEAT
A,B,C,D - THROTTLE STEAM PRESURE, PSIG
E,F,G,H - CONDENSER - BOILER STEAM PRESSURE, PSIG
I, J - CROSS-OVER STEAM PRESSURE, PSIG

Fig. 3. Average net heat rates for condensing steam power stations at various pressures, compared with mercury steam cycles and "topping" steam turbine cycles (C. C. Whelchel in "The Electric Power Industry")

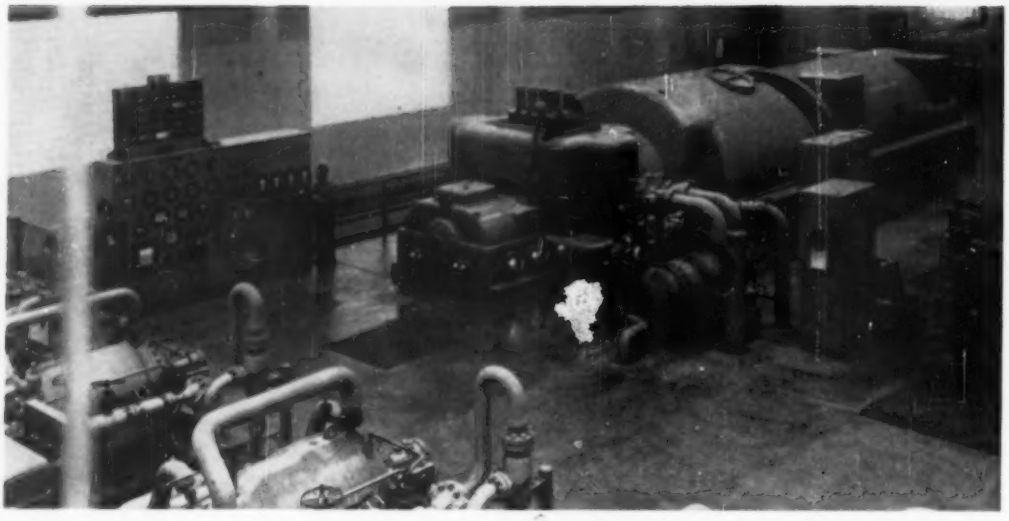


Fig. 4. One of the two 100,000-kw, 3600-rpm steam turbine generators installed during the year at Station P of Pacific Gas & Electric Co. Boiler feed pumps, control panels are shown. (See PG June, 1949)

the way down to standardized "package" type units of 15,000 to 50,000 lb per hr capacity for industrial use.

Water Treatment:—Modern high-pressure, high-temperature boilers cannot have any form of solids in the water that might cause scale, hence water treatment, both external to the boiler and internal, has received much attention.

In particular, at modern high pressure and temperature, carry-over of silica from boiler water causes turbine deposits that reduce capacity and efficiency.

So the water chemists have many methods of treatment available: various combinations of zeolite and hot or cold process lime-soda softeners, precipitators, ion exchange resins; phosphate and sulphite treatments and so on, for control of pH, concentration of total solids by continuous or intermittent blow-down and the like.

Soot Blowing:—One most effective tool for external boiler surfaces is the retractable de-slagger. Another is the use of compressed air for soot blowing instead of costly steam generated in the boiler; this replaces a steam auxiliary with a motor-driven compressor. Another is the automatic sequential control for soot blowing, either with air or steam, aiding thorough cleaning.

Feedwater Heating:—In the central stations, the regenerative feed heating cycle is almost universal; in this, steam is extracted from the turbine at various points for feedwater heating, after having done work in the turbine. In many units, four extraction points are used.

Internal Cleaning:—Solvent cleaning of boilers, condensers, heaters and heat exchange equipment is so well established that it is now considered a fundamental operating and maintenance tool of the power engineer. In fact, some steam generating units, such as that in Fig 8, are so designed that they can be cleaned only by chemical means.

Smoke Abatement and Flue Gas Cleaning:—Smoke abatement activities increase in intensity because the problem must be attacked first to minimize emissions from some present equipment, which cannot be readily replaced or rebuilt; and second, to see that the causes of atmospheric pollution are understood and proper designs developed to prevent emissions. It is becoming well understood that industrial and utility smoke is not the sole cause of air pollution and that mere passage of city ordinances and "smoke laws" does not solve the problem.

All power plants that require it are equipped with mechanical, electrostatic or, in a few cases, washer-type precipitators for removing fly-ash from flue gas. Some of the newer stations are installing combination mechanical and electrostatic precipitators. Much work is being done on effects of sulfur compounds emitted from stacks.

Industrial Steam:—While there is

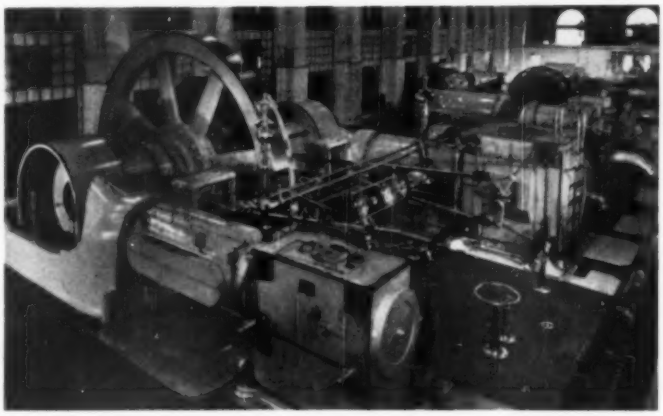


Fig. 5. Many of the present generation of power engineers got their first operating experience on Corliss engines like this one. It is "Old 1561", a Cooper Corliss in continuous service at National Cash Register Co. since it was installed in 1901; removed to save space a couple of years ago and now resting in a special engineering Hall of Fame at Dayton, O.

not the standardization in boiler design found in turbines, still various manufacturers are developing standardized types that will fit many different situations, in capacities from 15,000 to about 300,000 lb per hr. Some manufacturers also have completely self-contained or "package" units for industrial use up to about 50,000 lb per hr that can be shipped in completely assembled units.

In industrial power plants, where process steam demands govern the design, most new plants producing electric power, with extraction or back-pressure turbines, generate steam at about 400 psi and approximately 700 F steam temperature.

Total generation of steam in industrial plants for process and heating is much greater than the generation of steam by power utilities. Industry, however, has only about one-fourth as much capacity to generate electricity. Thus the problems of generating steam, burning fuel and utilizing large numbers of relatively small steam generating units and their auxiliaries, are extremely important in industry.

Progress in details of equipment and methods can be barely indicated here. Control of steam temperature at highest levels by gas dampers, superheat burners, divided furnaces, condenser type controls, attemperators, vertically-adjustable burners and other methods, is necessary.

Makers of boiler feed pumps are solving corrosion-erosion problems with alloy construction. Piping and valves develop to meet high- temperature stress and expansion problems. Draft equipment shows steady progress. Hydraulic couplings on fans and feed pump drives, and magnetic couplings on fans, are increasingly used.

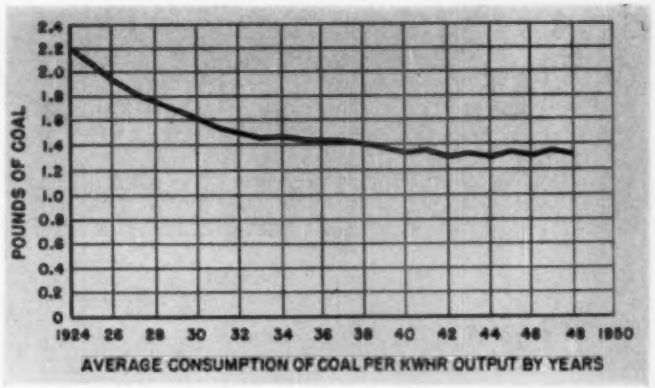


Fig. 6. Curve showing how coal per kwhr has been reduced in the private utility industry more than 40 per cent in 25 yr. About 1900 the coal consumption was probably around 10 lb per kwhr. Average consumption has hovered near 1.3 lb per kwhr for about 9 yr since 1940 and for 1949 is given as 1.2 per kwhr. (From "The Electric Power Industry")

Centralized Control:—As units become larger, auxiliaries farther and farther apart, operating labor more costly, centralized control of operations becomes more important in plants of all sizes. For a long time, automatic controls and instruments have been developing so they can be used with reliability for this purpose, also to promote safety and economy on load deviations. There is much development in pneumatic and electric transmitters for control and telemetering.

Outdoor Units:—Because of rising construction costs, unhoused or semi-housed units are often employed to reduce building cost. A few per cent thus saved may be a quite appreciable investment.

Condensers:—Many condensers are now of welded construction; the neck is rigidly fastened to the turbine and the condenser is supported on springs. To reduce leakage, tubes are rolled to sheets at both ends; shells may have expansion joints or tubes may be bowed.

A modern development is the vertical condenser circulating water pump, requiring small floor space and low net positive suction head. There is a trend to these; also available are vertical condensate, boiler feed, heater drain and other pumps.

Another step in eliminating steam auxiliaries in high-pressure high-temperature stations is the use of rotary valve positive displacement vacuum pumps in place of steam-jet air ejectors for removal of air and non-condensables from condensers.

Coal-handling:—Use of tractors, bulldozers, carry-alls and other mobile equipment developed by the earth movers, for storing, compacting and reclaiming coal, is increasing. Ash removal from furnaces by hydraulic sluice and vacuum system is well established.

Combustion Equipment:—Pulverized coal is the fuel for most central stations, permitting wide range in coal selection. A few stations use the central or bin and feeder system, pulverizing the coal at a central point and distributing it. Most, however, use the unit system, each boiler having its own pulverizers. Mill drying of the coal with air is common practice.

Several recent plants have been put in operation burning pulverized anthracite.

Stokers:—The past few years have seen the stationary power boiler in industry fired by pulverized coal, oil or gas or combinations, in the sizes above 150,000 lb per hr. But below this size, many industrial boilers are now fired by the spreader stoker, usually with continuous ash discharge traveling grate. This firing has a thin fire bed, many of the fines ignite or burn in suspension and the stoker responds rapidly to load changes. Overfire air is used to

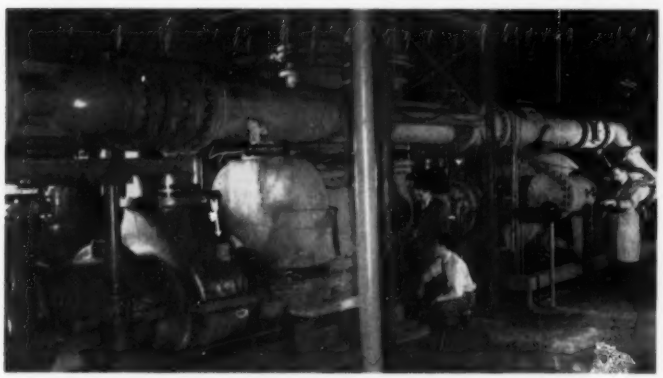


Fig. 7. View of coal-burning gas turbine now under test by Locomotive Development Committee at the Alco plant Laboratory, Dunkirk, N. Y. This turbine, a Houdry unit loaned by the Bureau of Mines, operated continuously on its first test for 40 hr, burning pulverized coal without difficulty. Extensive tests with pulverized coal on this unit will yield data for use in gas turbines now under construction by Allis-Chalmers and Elliott for LDC coal-burning gas turbine locomotives, details of which will be given in a future issue. Much work has already been done on coal-feeding equipment, coal pumps, combustors, regenerators and accessories

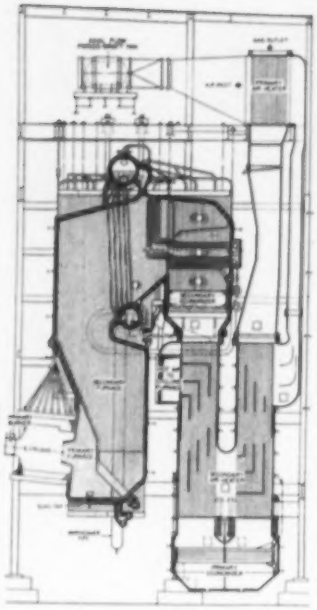


Fig. 8. Cross-section of one of two 400,000-lb-per-hr, 1280-psi, 900-F B&W steam generating units fired by cyclone furnaces, installed in new South Side Power Plant of Dow Chemical Co., Midland, Mich. These units are similar to cyclone-fired unit, Boiler No. 13, now in operation at Dow's West Side Power Plant, as described in detail in PG, March, 1949 issue

improve combustion and prevent smoke; fly-ash is often reburned.

There are still many underfeed stokers in operation; and in small installations, the single-retort underfeed stoker has many applications. Traveling grate stokers for anthracite, coke breeze and some of the Midwestern coals are used in many plants.

Cyclone Furnace:—This latest development in coal burning is producing great hopes for the future of coal burning. It is designed fundamentally as shown in Fig 8, and is intended to burn coal crushed to ¼ and below—but not pulverized—convert the ash in the coal into molten slag, have a heat release of about half a million Btu per cu ft per hr, trap most ash particles in the molten slag so they will not pass into the boiler and dirty it nor cause a stack emission, and discharge the molten slag and ash in liquid form to a sluice. The result is less need for cleaning stack gases, reduction in size of boiler equipment and its maintenance, less labor for cleaning.

To date 54 cyclone furnaces have been sold to serve 19 new boilers with total output of 10,000,000 lb steam per hr. Eight cyclone furnaces are already in operation, others under construction at this writing.

The boilers of Fig. 8 operate entirely on forced draft, the boiler casing being sealed and the furnace under pressure. No induced draft fans are installed.

In operation of the cyclone, which is about 8 ft. in diameter, and inclined about 5 deg from the horizontal, primary air and coal enter the cyclone tangentially at the front and are whirled around the cyclone, secondary air is introduced tangentially as required and tertiary air helps move the gases lengthwise to the throat where they pass to the secondary furnace and boiler. The cyclone action coats the inside of the cyclone with molten slag, which traps all combustible matter and burns it out and the molten ash flows out the tap hole. Tangential firing has been used for years, but not in just this way.

The boilers fired by cyclones operate at efficiencies averaging 90 per cent. About 85 per cent of the ash is retained in the molten slag, 5 or 6 per cent is gasified, and the remainder is discharged through the stack with the flue gas.

Mercury-Vapor Power Plants:—Before the war only three installations of the mercury-vapor power plant were in existence; but in these, most of the early operating problems had been solved. War stopped further development, but this year two new mercury vapor power plants have been installed, and one new unit at the original plant. The relative heat rates of mercury plants are shown in Fig 3.

Although recent high-pressure high-temperature reheat stations have been designed for net station heat rates of about 9200 Btu per kw-hr., they are relatively large stations, with 100,000 or 150,000-kw units.

One new mercury plant, with a total of 40,000 kw combined mercury and steam capacity, is also designed for this same rate of 9200 Btu. Furthermore the mercury plant operates at low mercury pressure and its steam section at only 600 psi, 900 F, hence the equipment cost is kept down.

Gas Turbines:—The gas turbine for stationary power arrived in 1949 and promises to be one of the power engineer's most valuable tools for the future.

1—In the spring of 1949, the 4500-hp G.E. gas turbine locomotive, burning Bunker C fuel, was demonstrated and has been in commercial freight service on the Union Pacific Railroad since July.

2—The 3500-kw gas turbine generator, Fig 2, was put in service in July. It burns natural gas and its exhaust heats feedwater in a steam turbine cycle, thus permitting the steam turbines to generate an additional 3500 kw of power. (See PG, December 1949 issue.)

3—A 2000-hp gas turbine went to work driving a centrifugal compressor on a natural gas pipe line.

4—A 5000-kw stationary gas turbine, designed for burning Bunker C fuel, is now on test and will be installed next March by a Maine utility, solely to drive a generator for augmenting the company's generating capacity. Also on test is a 3500-kw unit, similar to the Oklahoma unit, for another Maine utility. Several other gas turbines for stationary service are on order.

5—Actual operation, even though only for a relatively short period, of

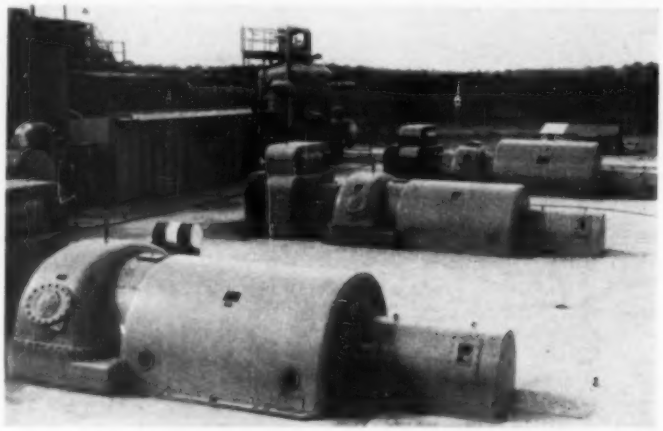


Fig. 9. Three steam-turbine generators installed and operating entirely outdoors at Coughlin Generating Station of Central Louisiana Electric Co., Inc. These are GE units, one of 10,000-kw and two of 7500-kw capacity. Outdoor boilers at left

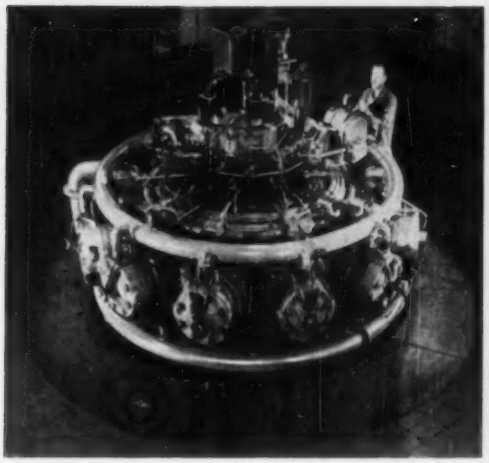


Fig. 10. One of most important recent developments in the Diesel engine field—the new Nordberg 1800-hp radial heavy-duty stationary Diesel engine, now being built in large numbers for use in the aluminum industry

Fig. 11. Five of nine hydroelectric generating units, each of 108,000 kw capacity, in the West Power House, Grand Coulee Dam. Three similar units now in operation in East Power House. Present total installed capacity 1,296,000 kw

an experimental stationary coal-burning gas turbine, from which data will be used to develop a coal-burning gas turbine locomotive, the turbine for which is already built.

Many more gas turbine and free-piston engine and marine gas turbine developments are under way. The Navy's gas turbine at Annapolis has operated for long periods at 1500 F.

Atomic Power Plants:—All the above is where the power field stands today, looking forward to atomic power in 25 years. All that power engineers have done to date will fit into the atomic power plant and any others that may come. The surface of power development has just been scratched. Many who read this will see developments too strange to imagine now.

Diesel:—The most important recent development in the field is the dual-fuel engine, which operates on either Diesel oil or gas, depending on the gas supply, changing from one fuel to the other automatically.

This greatly extends the possibilities of the internal combustion engine, since gas can be burned when most advantageous, saving oil for supplementary use if the gas supply fails.

Hydroelectric:—Although the bulk of recent hydro development has been on a river basis, by the Federal Government, and probably will continue that way in the main, still the Federal Power Commission has now before it applications for 4,500,000 kw of hydro power from private utilities and industries, not in any way public organizations. This is almost as much as the 5,000,000 kw of capacity for private sources applied for during the first 25 years of the Commission's existence.

Great public projects like Bonneville, Hoover, Hungry Horse, Grand Coulee, Fig 11, have filled the public eye for 15 years. An unusual development is the Grand Coulee pumping station for irrigation pumping. Here the pumps will deliver 1600 cfs, each pump will be driven by a 65,000-hp electric motor and the motors will be driven by connecting a pair of motors electrically to one of Grand Coulee's 130,000-hp hydroelectric generators and starting up the entire assembly by opening the hydraulic turbine gates.

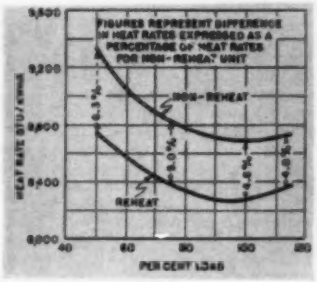


Fig. 12. Gains in economy resulting from reheat; improvement varies with load on turbine (C. C. Whelchel in "The Electric Power Industry")

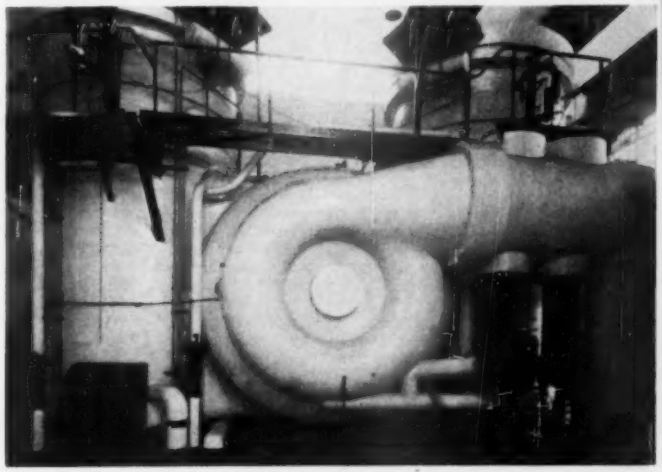
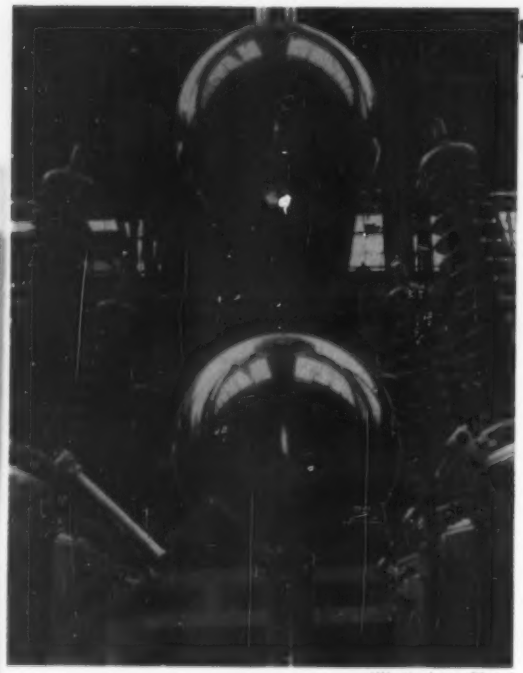


Fig. 13. General view of new GE 15,000-kw mercury turbine, South Meadow Station, Hartford Electric Light Co. Unit has produced 42,138,000 kwhr net from Jan. 2, 1949 to June 15, 1949, plus 49,411,000 kwhr equivalent from steam generated in two condenser boilers in background

ELECTRICAL ENGINEERING—



(Westinghouse Photo)

Only the most presumptious kind of thinking would dare to predict what the next fifty years will bring in the development of Electrical Engineering but certain developments today enable us to see dimly a few of the things the years to come may bring. While there will be great advances in the generation, transmission and utilization of electrical power in industry the greatest achievements probably will lie in the field in which the electrical scientist will have to work with the biochemist and neurologist

By ANDREW W. KRAMER,
Editor, Power Generation

WHEN MICHAEL FARADAY demonstrated his first dynamo, Gladstone, who was present, asked what it was good for. Genius that Faraday was, he could hardly have realized the measure of truth in his answer to the skeptical statesman's question when he remarked that some day the new toy might be good for taxation. Last year, the electric utilities whose operations are based upon Faraday's toy, alone paid out over eight hundred million dollars in taxes in the United States.

It hardly seems necessary to direct attention to the great importance of electricity in the world today because we are all familiar with the part it plays in our lives, yet, this year it seems fitting that we survey briefly the electrical developments of the last 50 years and speculate upon what the next 50 years may bring forth in the way of electrical development.

The use of electricity has become so commonplace that we often fail to understand how much we depend upon the efforts of the electrical engineer in every aspect of our civilization. Most of us, of course, realize that when we flick on a light switch, that the light and the switch and the power system behind the switch are the products of electrical engineering; we know also that when we listen to our radios or look at our television receivers or talk over the telephone, that these things are the results of the electrical engineer's work. We are less prone to think of electricity in connection with other of our activities—the part it plays in the food we eat, the clothing we wear, in keeping us healthy and free from disease, in supplying us with newspapers, magazines and books, in transporting us across continents and oceans. True, all of these things involve matters other than electricity but the fact remains, they could not be done as they are done today without the use of electricity.

Last winter, at the meeting of the American Institute of Electrical Engineers, Dr. Coates, Curator and Aquarist of the N. Y. Aquarium, gave a very interesting demonstration involving the antics of an electric eel. By means of a cathode ray oscilloscope he showed that this eel, when excited, was able to deliver some 300 separate impulses per minute at an average voltage of 370. These impulses, reflected on the screen of the projection oscilloscope, were something to think about. Here was an animal—a poor, ugly, blind fish—who could generate electrical energy, chemically, and control it by a process that few electrical engineers in the world know very much about. It made one realize, despite the amazing variety of electrical apparatus in the world today, how little we know about the basic electrical processes of life.

It is in this understanding of the electrical basis of life that we may look forward during the next 50 years for the greatest advances in the field of electricity because it is in this direction that most remains to be learned. Over and above the casual interest in the electric eel's voltage producing abilities lies the deeper understanding of the process he employs to generate these voltages. Some insight into this aspect of the eel's behavior have been provided by Dr. David Nachmanson, assistant professor of neurology at Columbia's College of Physicians and Surgeons. Dr. Nachmanson shows that the eel's electric "wiring" is followed in the nerve structure of all living animals, only their voltage

Where Does It Go From Here?

is a great deal lower. It can be shown that similar electro-chemical reactions are employed in transmitting impulses in the nervous system and the brain cells of man. While it has long been known that nervous impulses are communicated to and in the brain electrically, this electrical action is very different from what goes on in a metallic conductor.

In fluid mediums, there is no physical explanation of flow or movement of electrons. From long and continued research it has been found that the nerves are composed of series of chemical cells normally charged electrically. When an impulse is transmitted the cells discharge separately and progressively. Thus the discharge of each cell initiates the action in an adjacent cell. Conduction in the cells depends on the presence of certain enzimes—cholin-esterase. Removal of this cholin-esterase blocks conduction. The action is extremely complex and not easy to understand, but it is extremely fundamental and if, during the next half of the century we can gain a better understanding of this action it may have greater effect upon the human race than has the development of electronics in the first half of the century.

The Brain and the Electronic Computer

An indication of what we may expect from further research in this direction may be had from a comparison between the central nervous system of the human animal and one of the most advanced products of the science of electronics, the electronic computer. The more the neurologists learn about the human brain, the more it looks like an electrical calculating machine. The brain is made up of neurons (nerve cells) which are nothing more nor less than small electrical relays, each containing its own electrical power supply. The cells burn sugar to CO_2 and water, and the energy thus released is used to keep the outer surfaces of the cells electrically charged with respect to their interiors. The charge amounts to about 0.07 v. These nerve cells are connected by slender, wire-like fibers (neurofibrils). Like the cells, these fibers are electrically charged. Normally, a nerve cell is like an electrical relay waiting for a signal to actuate it. When the signal—a pulse of energy from another neuron—arrives, the cell *fires*. An electrical disturbance starts at its center and travels outward along all its fibers. When the pulse reaches the end of the fiber and touches the fiber of another cell, it may, or may not, *fire* that cell, too. This selective action is the basis of the brain's operation.

The neurons are only one-thousandth as fast as vacuum-tube relays, but they require much less space and much less power. If an electrical computing machine had *only* 10 million vacuum tubes (the brain has 10 *billion* neurons), it would take the power of Niagara Falls to operate it and the waters of the Niagara River to cool it. The brain is cooled by a comparatively small river of blood. When awake, and in full operation, it raises the temperature of a pint of circulating blood one-half a degree per minute.

The Intelligence of a Flatworm

One of the electronic wonders of this age is the electrical calculating machine. They have been getting bigger and bigger, better, more complicated, and more difficult to operate. But they have a long way to go before they rival the brain. A big computer with 10,000 vacuum tubes may be a formidable and highly useful machine, but, according to Dr. Warren McCulloch, it has no more *intelligence* than a primitive flatworm with about that number of cells.

It is because we know so little about these things that we can hope to learn so much in this field. So far, its surface has scarcely been scratched. It is in this field that the electrical scientist will have to work with the neurologist and it is here that he will find an entirely different set of rules. Basically, the action in nervous systems is electronic but it is beset by strange chemical phenomena which greatly complicates our understanding of it. Our most complex power systems or telephone systems are simple and easy to understand compared to electrical action in living organisms.

Probable Trend in Power Development

Our electrical power systems have already reached a high degree of perfection and though we can expect steady improvement during the next half century, it is improbable that the present order of things will change much. The modern electric generator is a very highly developed, efficient machine. Undoubtedly, refinement will be made in attaining greater compactness through more effective cooling methods and the use of improved magnetic materials but, fundamentally, the nature of the machine will not change.

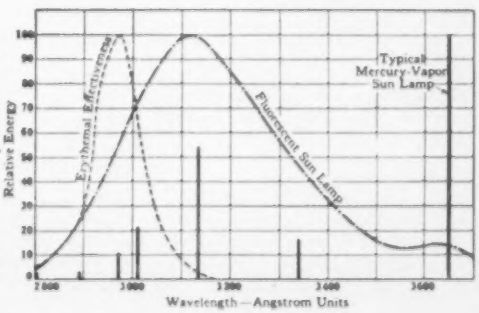


Fig. 1. New light sources will be developed. Here are shown relative energy distribution curves demonstrating the great effectiveness of a new fluorescent sun light. This lamp which possesses all the desirable features of the regular fluorescent lamp but is considerably more erythemally effective per watt of lamp input than any other sun lamp ever devised

Fig. 2. A 1250-hp. 2300-v silicone-insulated tube-type motor driving an induced draft fan in a power station. Silicone is an example of a new material that may greatly change the design of electrical machinery for use in high temperatures

(Photo, courtesy, Allis Chalmers Mfg. Co.)

Higher voltages probably will be used. In this country generator voltages have centered mainly around 13 kv and in only very few cases are generator voltages of 22 kv used. In England, on the other hand, generator voltages of 33 kv are in common use, and it can be assumed that as generators become larger, the voltages will increase.

Transformers are in the same category with generators with respect to further improvement. The modern power transformer is the most efficient machine man has ever devised. Large units have efficiencies of 99.6 per cent. Here again, improvement will be in the attainment of greater compactness by more effective cooling and even better magnetic material.

Among the noteworthy turbine-generator units installed in 1949 was the 150,000-kw tandem-compound, 1800 rpm unit at Fisk Station of the Commonwealth Edison Co. in Chicago. The one-piece stator of this machine, physically the largest so far constructed, weighs 398,000 lb.

The rapid increase in capacity of power systems and the expected increase in future years will justify the construction of even larger generating units. Even now, some systems justify the use of generators with ratings of 200,000 to 225,000 kva. These can be met with single unit, 3600 rpm hydrogen-cooled generators of present day construction operating at 30 psi gas pressure. With reasonable improvement in the physical characteristics of alloy forgings, and somewhat better rotor ventilation, and insulation, it is anticipated that 3600 rpm, 250,000 kva generator units can be built as soon as the need for them arises.

New Materials

The greatest possibilities for still larger increases in ratings can be expected from new insulating materials, improved methods of ventilation, and the use of new cooling media. Generator insulation of the future will be very different from that we use today. The contributions of chemical research to the insulations of the future will predominate. Many new promising synthetic insulations are already available, as yet untried in windings, offer prospect for considerable improvement. Insulations eventually will be almost wholly man-made or synthetic. Mica, if not obsoleted by something better, will probably be made in the crucible in a few hours rather than by nature during many millenniums in the earth's crust. It may no longer be necessary to depend on mica flakes as dielectric barriers of high thermal endurance. Higher intrinsic dielectric insulation strength will permit the building of machines for higher operating voltages and will allow more room for copper and have the advantage of further reducing the thermal gradients through the insulation.

But the greatest gain in generator construction will result from the development of far superior methods of cooling using either the present or new media. Almost certainly, hydrogen will be used at considerably higher pressures but liquid cooling of machines may be developed. Independent investigators have already submitted designs using liquid cooling and evaporation cooling.

New Principles of Electric Generation

These, it will be noted are all refinements in the construction of present day types of machines, that is electrodynamic machines. Since the beginning of the electrical industry, engineers have dreamed of more effective methods of converting thermal energy into electrical energy. As early as 1823 Seebeck discovered the thermoelectric effect, and many investigators have tried to put that effect into use in a practical thermoelectric generator but so far none of these attempts have been successful. The recently discovered silicon carbide-carbon thermocouple used in the steel industry for high temperature measurement offers new possibilities in that direction. Basically, the thermocouple is an energy conversion device subject to ordinary thermodynamic laws, and it may be possible some day, to convert the heat of combustion of fuel directly into electrical energy. If this proves possible with even a reasonable degree of efficiency, in time all present day electrodynamic machines will be discarded.

In the field of electric transmission, in the reasonably near future the maximum commercial operating voltage can be expected to increase from the present level of 287,000 v, to 400,000 or even 500,000 v. The work being done at the present time by the American Gas and Electric Service Corp. is in that direction. There are those who believe that the future use of 500,000 v is doubtful but there are no good engineering reasons why such voltages should not be developed. At the present time there may be no commercial need for 500,000 v but with the future use of nuclear power plants in remote regions such voltages may be necessary. There, certainly will be no difficulty in building transformers for such voltages and switchgear, also, can be developed. In capacity, a top level of 145,000 kva in a single transformer has been reached this past year. Two hundred thousand kva can be provided when needed, even now, but there is no reason to believe that this represents a top limit.

Interrupting 10 Million Kva in 3 Cycles

In the construction of switchgear we have gone so far beyond anything we could envisage 25 years ago that there appears to be no practical limit as far as interrupting capacity is concerned. Last year (1949) saw the completion and delivery to the Grand Coulee Dam switchyard of the first 10,000,000-kva, 230,000 v, completely coordinated package switching units ever built. The units combine the highest rated commercial 10,000,000 kva power circuit breakers ever built. These units have a continuous rating of 10,000 kva, and a 3-cycle interrupting time.

These achievements in greater capacity, and higher voltage of transformers and switchgear are all along conventional lines and in thinking of future development one should be careful not to rule out the development of entirely new materials and methods. Every electrical designer includes among his dream materials, a conductor of lower resistivity than copper. At present there seems little prospect of this in any known alloy or metal, the search having gone on since the industry's beginning. In this field, however, the effects of extremely low temperature provide a most fascinating realm of speculation. At the temperature of liquid hydrogen —a few degrees above absolute zero, all resistance disappears and a current started in a closed ring will

continue to circulate indefinitely. This phenomenon should not be ruled out in thinking about future developments either in transmission or electrical apparatus in general. Fifty years ago, the idea of an oil or gas-filled cable might have seemed far fetched, yet today, such cables are in use. Entirely new techniques may come into use. If the designer of tomorrow should be favored with all three dream materials—core, conductor and insulator—or a reasonable facsimile of them, the transformer of tomorrow for example, might be enormously reduced in dimensions, with core and windings cast into a solid mass of insulation. The steel exterior would become unnecessary. The whole solid unit could, if desired, be buried in the ground, with power entering and leaving by underground cable.

The recently developed butyl-moulded current transformer is a forerunner of this type of construction. In this construction, the core and winding components of the transformer are assembled, baked out completely, and properly positioned in a hot cast-iron mold. Butyl is then injected into the mold under controlled pressure and temperature. When the mold is completely filled, a mechanical shut-off is closed to retain the pressure and the mold is placed between two hot steel plates for curing. Since the nameplate information and polarity markings are molded directly into the surface of the butyl, the only subsequent operations are to remove the flask, color the nameplate and polarity markings and attach the secondary terminal hardware.

Or perhaps, instead of the solid dielectric, some new synthetic fluid—liquid or gas—will be produced that is a better insulating medium than oil. Such a medium will be under several atmospheres pressure, thereby obtaining the advantage of greatly increased insulation strength. Thus we might sometimes see the high-pressure tranformer, perhaps buried underground, with cable systems entering the transformers and distributing energy very much like oil and gas pipe lines.

Maybe A Vacuum

Some engineers suggest that the trend in electrical insulation for high-voltage apparatus may lead in the opposite direction—to no liquids or gases and no high pressure. Instead a high vacuum. In a vacuum, there being nothing to ionize and cause breakdown, the problem of high-voltage insulation is greatly simplified. This enlarges the problem of disposing of the heat but with the assumed low-loss core and conducting material the heat to move is greatly reduced so that the scheme might not be impractical.

One can hardly imagine that the day will come when the transmission of electrical energy between generation and utilization will not require transformers. Let us assume, for example that for some reason that we do not now comprehend, it becomes desirable and economically practical to use high-voltage d-c transmission. Transformers will still be required between the generator and the rectifiers at the sending end of the line and again between the rectifier and the sub-transmission and distribution stations at the receiving end of the line.

Space Transmission of Power?

No matter how much we might like to let our imaginations roam there seems little possibility that we will ever be able to do away with our power transmission lines, that is, transmit large amounts of power through space. True, we send power through space now in our radio communication systems, but the amounts involved are small and the dispersion, even with "beam" systems, is great. Despite all this it is still not wise to be too positive in making

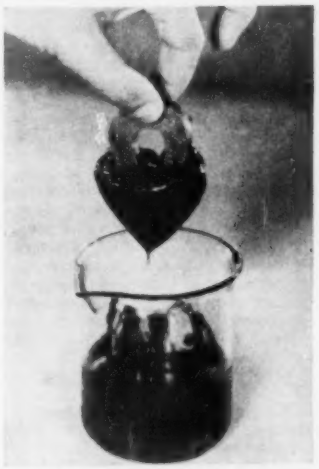


Fig. 3. The principle of the magnetic fluid clutch. When finely divided iron is mixed with a liquid such as oil and the mixture placed in a magnetic field, the magnetic particles will firmly bind together. Here, a gob of such a fluid mixture is picked up by a small horse shoe magnet. This is an example of a new discovery that may lead to vast improvement in the design of equipment

such negative predictions. Twenty-five years ago, the idea of emitting high frequency electromagnetic pulses having energy levels of thousands of kilowatts would have seemed fantastic, yet with the cavity magnetron and suitable radiators this is exactly what we do in radar today. The day may come when we send high frequency energy over long distances through evacuated wave guides. No one can foresee what the next 50 years may bring in the way of new and undreamed of developments in high frequency techniques. Today, The Southern California Edison Co. is using microwave equipment operating on a frequency of 960 mc, for telephony as well as for supervisory control and telemetering. This is the first use of such equipment by a power company.

Electronics—It's Big

Microwave technique is a part of the great field of electronics and this is a division of electrical engineering so vast, so complex, and so fraught with possibilities that it is almost presumptious to even speculate on future developments. Today, we have not only radio, but television—color television, in fact—and radar; who can say what tomorrow will bring in this field. The electron microscope, less than two decades old is unrolling the veil of mystery from the infinitely small. Two years ago, we transmitted radar impulses to the face of the moon. Our electronic computing machines operate so fast that the trajectory of a shell is calculated before the shell can traverse that trajectory. The cyclotron produces particles with energies of almost 400 million electron volts. We take x-ray photographs in a millionth of a second and at the Naval Research Laboratory in Washington a camera was developed with a shutter so fast that it chops off a beam of light 3 ft. long. And the Geiger counter is so sensitive that we can detect with it the impact of a single atom.

Then there is a strange new device—the semi-conductor which two years ago developed into the transistor. This simple gadget, which is so small that you put several of them in a thimble, will detect and amplify just like the triode vacuum tube. Still in its embryonic stage it gives promise of great developments. In electrical computing machines, the transistor may make possible the concentration of hundreds of thousands—even millions of elements giving us the approach to the central nervous system of living things mentioned earlier in this article. In such machines, the transistor would greatly reduce the problems of heat dissipation since these little devices require no heater current.

Another marvelous development in electronics is RCA's Selectron tube, a tube developed specially for use in electrical computers. The selectron, in a single tube will be able to do what the famous Eniac at the University of Pennsylvania needs 18,000 tubes to accomplish. These computors will multiply ten digit numbers in a millionth of a second.

New Tubes

The introduction, last year, of a new radio receiving tube in which an electron beam is focused upon a grid through a narrow slot in a positive accelerator marked a radical departure from conventional

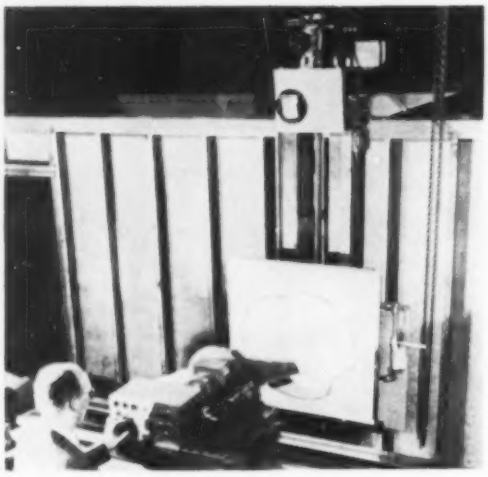


Fig. 4. This optical contour-following system follows a fine-line drawing with a machining accuracy of one mil

(Photo, courtesy, General Electric Co.)

design. This tube, called the grated beam tube, represents the first large scale application of this form of *cathode gun* to receiving tubes. In addition to use in FM and television limiter circuits and reducing the set component cost, this development opens up an entirely new field of design possibilities.

It is impossible for anyone, even those who are experts in the field, to make any predictions as to what the next half century may bring forth in the field of electronics. The field is so vast, the amount of investigation going on so extensive, that new ideas are brought forth every day. Many of the new developments are by-products of other researches. An excellent example of this is the multiplier phototube which now plays a vital role as a detector in nuclear and cosmic ray work, and has found innumerable applications in industry and research. Immediate interest in secondary-emission multiplication stemmed from the need of increasing the signal strength of television pickup tubes. Again, the electron microscope, which has extended our vision by two orders of magnitude, naturally fitted into the orbit of interests resulting from the intensive occupation with the electron-optical problems of television. The infrared-sensitive image tube, which came to play such an important part as a reconnaissance instrument during the war, was another early by-product of pick-up tube research. And now, a variety of *storage* tubes, (the selectron mentioned above) the offspring of television research in tube construction, operating principles, and circuitry, promise to make material contributions to air safety through systems such as Teleran, to facilitate the study of high speed phenomena, and to bring within reach the solution of mathematical problems of baffling complexity by modern electric computing machines.

The possibilities are endless. The most fertile imagination on earth can paint no picture of what electrical science and engineering will bring us in the next 50 years, but in the achievement of television and radar, in the strange and marvelous servo mechanisms we have developed, in the idea of the automatic computer, we can see dimly that the wonders we have today are but stepping stones to a greater electrical age undreamed of today.

Feedback and Cybernetics

The development of servo mechanisms deserves mention since these systems are coming into greater use in all aspects of civilization. To mention a single instance of how this old principle is being applied today, take the optical contour following system developed recently for use in machine shops. This device causes a machine tool to follow a fine-line drawing with a machining accuracy of one mil. Now, *feedback* upon which all servo mechanisms operate, is an old principle. The modern industrial age was born many years ago when feedback was applied in the design of the steam engine valve mechanism and governor. The more recent automatic ship's helmsman, developed by the mechanical engineering profession, predates the acceptance of the feedback principle by the radio engineer but before that the electrical engineer had used feedback in many types of electrical regulators. The milestone, in mathematical development of the feedback theory and its application to the electrical communication art, is the classical contribution described by H. Nyquist in 1932 and by H. S. Black in 1934. In the subsequent decade feedback appeared to be only a technical detail of particular interest to specialists in the communication field but the fuller significance of feedback was realized during the last war when the combination of already available electronic apparatus and daring *imagineering* stimulated the rapid exponential growth of servo mechanisms, calculators, and control devices. When complex circuitry is equipped with reverberating memory circuits, information storage circuits (selectron) calculating circuits, and circuits which teleologically feel back a signal over a goal, these manifold electronic assemblies begin to exhibit frustration, inhibitions, and *learning* ability.

All these matters—servo mechanisms, automatic computers, the action of the nervous system in living things, etc.—form a great new field of investigation, the field of Cybernetics. Cybernetics is a word invented to provide a name for activities combining under one heading the study of what in human context is sometimes loosely described as thinking and in engineering is known as control and communication. In other words, cybernetics attempts to find the common elements in the functioning of automatic machines and of the human nervous system, and to develop a theory which will cover the entire field of control and communication in machines and in living organisms.

As previously indicated, developments in heavy electrical engineering, in the field of power generation, transmission and its utilization in industry and domestic fields, will continue along lines already laid down. There will be great refinement, new marvelous materials will be developed, there will be greater compactness, efficiency and reliability in the design of all classes of apparatus. We may change from a-c to d-c for long distance power transmission, we will develop greatly improved lighting systems, new sources of light will appear, television will come into its proper sphere of usefulness both as a means of entertainment and as an aid in industry. Communications systems will grow even beyond their present high state of development, in all branches of the art, wire, space radio, coaxial and waveguide, but the present wire and cable connected telephone system will not change fundamentally. Nuclear power development may make necessary much larger concentrations of power than we have today and this will necessitate larger generators, transformers and switchgear but unless the electrodynamic principle of generation is superseded by something like the thermoelectric generator, this class of apparatus will develop along present lines.

LETTERS TO THE EDITORS

A LABORER'S CRITICISM OF ENGINEERING EDUCATION

IT SEEMS TO ME that in "A Laborer's Criticism of Engineering Education" Mr. Bourbonnais is not writing from a common laborer's viewpoint. For in common labor all work is interchangeable. Each man toils to the best of his strength, endurance, knowledge and skill, without any natural or artificial division of the task. The only limitations imposed to any exchange of places among the workmen is the inability to withstand heat, cold, mud, rain, dizzy heights or unrelenting toil. In this so-called lowest field of human endeavor men get paid for what they do, not for what someone else does, or for what they may, or may not, know. Perhaps the greatest fault in our educational system is the failure to teach this fundamental fact, that so-called common labor is the trunk and bole of our civilization, and that all else is limbs, branches, twigs, leaves, buds, flowers and fruit.

As I understand his criticism, what Mr. Bourbonnais advocates is a further, or perhaps more rapid, division of work, this division beginning with the trades. Each trade, formerly represented by the guilds and now by the unions, claims a definite field of craftsmanship, and bars, or attempts to bar, other unions from jurisdiction within that field. Often, as in the industrial or "vertical" union, a single union may be recognized as authoritative in a whole industry. There are coal miners, for example, who do not handle, perhaps have never handled, a single pound of coal. They are the men who do carpentry, electrical work, etc., in and about the mines.

While an engineer was originally trained to correlate and adapt physical and chemical laws to further the end products of a plant, industry, or sub-division thereof, division and subdivision of work has occurred until we now have engineers trained in all of the branch services, combustion engineers, electrical engineers, refrigeration engineers, etc. Further division is occurring, and doubtless will continue to occur. The complaint Mr. Bourbonnais registers is that division is not taking place rapidly enough. Certainly it is not taking place as rapidly as technological advances in the engineering profession as a whole. But this is due to the time lag between these technical developments and the education of engineers to understand them.

In this light all education is s e c o n d-hand experience, e v e n though it is the sum total of all generally known experience. Mr. Bourbonnais to the contrary, it is neither necessary nor desirable to separate too widely the practical from the theoretical, the draftsman from the I-beam he draws, or the structural engineer from the corrosive effects of the weather on his work.

Your very truly, Uncommon Laborer,

Decatur, Illinois — GEORGE HOLMAN

AN ENGINEER LOOKS AT LABOR

THE ARTICLE BY Mr. Bourbonnais on page 76 in the November issue is certainly one c o m p e l l i n g serious thought and consideration. Mr. Bourbonnais does not touch one element my personal feelings have always felt our educational system has not stressed. It is simply the little reference to ways, means and methods of EARNING A LIVING, or what may be more to the point, the approach to self-support. Many will instinctively welcome an elysium of lotus eaters like the youth who wants to buy or own a motor car but have someone else endow it.

Without too much of a reminiscent tone my own approach was essentially through the "back door." Never having in my youth any lavish control of funds, I began shoveling snow at an early age and our coal supply was carted to a distant cellar by my brother and myself. Due to family financial reverses, I entered the business field as an office boy before the age of 15 and after some 5 years, including various activities, trolley company s t o r e k e e p e r, apprentice wireman, station operation, the urge for more basic education terminated in 2½ years at high school and 4 years of technical training. Perhaps working as a laborer would not be the correct term but at least manual methods are not strange and activity during summer periods in shop work, terminating after graduation in a test course, makes certain productive methods not at all strange, through exposure at least.

For my experience the first two years of college work for all courses were essentially the same. This approach seems basically correct since during this formative and developing period the student can usually make up his mind whether he has charted the course which seemed to suit his inclinations.

The decision about what course to take or what path to follow can never be definitely answered in a yes or no way and will always remain one of the insoluble mysteries of our economic setup. Mark Twain once wrote an amusing article about many famous men comparing their youthful aims and desires and their ultimate conclusion; one even wanted "to be a fireman and could only be editor of the Atlantic Monthly."

A great deal Mr. Bourbonnais says is absolutely without r e f u t a t i o n. Many of us would "be much happier" with an electrical operation of a manual nature than with theoretical work and personally I feel relaxation in greasing a motor car by hand. But having been an A. F. of L. apprentice when craftsmanship was considered an attribute, it is most distressing to find a $3 per hour metal worker unable to make a flux solution because he lacked the elementary knowledge of adding a quantity of water to promote the "chain reaction."

The absence of a worker with real mechanical instincts in city motor car repair shops is most noticeable. Even during a Far Eastern experience, it was noticeable how adept in the use of tools the country blacksmiths and other mechanics were. It is most disconcerting to have a service station mechanic (so-called) remark "we ain't mechanics" when merely asking for a bolt.

It is most noticeable to find how quickly an engineer, lacking practical experience, changes his viewpoint with some relatively short field construction experience. It is certainly true that if most designers had to install the layouts they make, their viewpoints and future approach would be totally different.

Since the U.S.A. labor situation has changed from the late Mr. Gompers's attitude of non-political affiliation to one of plain pressure politics we can expect anything but improvement in craftsmanship and discouragement in efficient ways of working. With bricklaying at one-third the 8-hour work rate, at 5 times the hourly pay rate, is it any wonder privately financed building is discouraged? In the electrical field does it make sense to have to have a $3 per hour man take a pipe coupling from a bin to give to a union applicant or have $3 per hour men unload a car of conduit, purely a laborer's work? Just what a "regular union man" needs to prove "the college man is a right guy" remains to date, of going along with a mass or a mob. According to the NLRB "sauce for the goose is not to be sauce for the gander," one side shall be ex-cathedra and do as it wishes to while the other is to be the underdog for every situation and "the employer is always wrong and is our enemy" a la Karl Marx. (Try it in Russia and see where you land.)

(Continued on page 94)

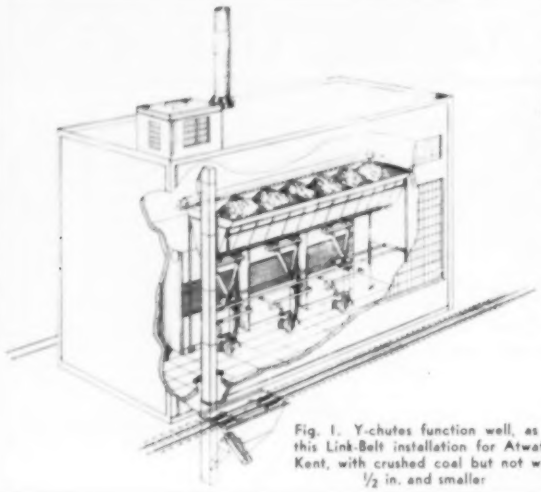


Fig. 1. Y-chutes function well, as in this Link-Belt installation for Atwater Kent, with crushed coal but not with ½ in. and smaller

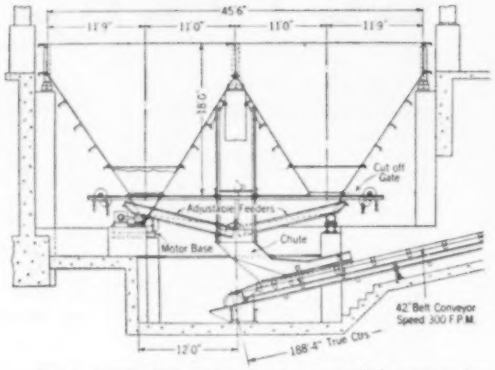


Fig. 2. Longitudinal section of twin, steep-sided receiving hoppers and inclined adjustable feeders serving rotary car dumper. Sides can be made steep and vibrators can be used to boost the coal along, in case there is any tendency for the coal to hang up at this point in the system

Chutes, Feeders, Gates, Grids and

By **WILBUR G. HUDSON**
Consulting Engineer

IN DEVELOPING the coal handling and storage layout for a steam plant, the designer runs into quite a number of tricky conditions, some of which are very troublesome. One of the worst came to life with the expanded use of small bituminous coals (½-in. and smaller, frequently damp) because of their resistance to flow and tendency to arch.

Action of Coal in Silos and Bunkers

The typical coal silo has an elevated floor sloped at 45 deg. With the coal dry, much of it will flow out; but it backs up from the line where the lower end of the shelf meets the silo wall. If the coal is damp, only a small fraction of the live storage is really "live," unless it can be boosted along by air jets. In an overhead bunker it ratholes up from each bunker gate, leaving dead storage between and becoming progressively worse as it compacts in storage.

It is a tough problem. Using the coal promptly after depositing it would help, but that is impracticable. So is drying it at the rate at which the conveying system handles it. Hot air jets directed through the mass sometimes help. Coal dried at the preparation plant before shipment flows readily unless it has been drenched en-route or has been stocked out in ground storage.

But the difficulty does not end in the bunker. The feed chutes to the stokers or pulverizers must serve these units without the interruptions resulting from arching or hanging up. That difficulty became so serious during the war years, when government regulations made it necessary to move much coal through reserve ground storage, that a lengthy investigation of the subject of coal flow in chutes was undertaken by Messrs. Wolf and Von Hohenleiten, who arrived at a chute design substantially improving the flow with the particular coal and under the conditions submitted to them. Their investigations are reported at length in *Power Plant Engineering*, July 1945 issue. The results with a trial chute constructed in accordance with their laboratory trials are discussed in *Mechanical Engineering*, April 1948, issue.

Trouble Starts Back at Cars

Our troubles start, however, back at the incoming cars. Fortunately, several effective devices for unloading frozen, semi-frozen and damp coals from cars are available. These were discussed in *Power Plant Engineering*, June 1946 issue. Build-up occurs again in the track hopper, but here we can make the sides as steep as possible and can boost the coal along by electric vibrators attached to two, or all four, of the hopper plates. Some probing is unavoidable. A typical track hopper is shown in Fig. 2.

Grid Desirable Across Track Hopper

A grid is desirable across the track hopper, since coal that has been brought in from reserve storage frequently has frozen or compacted lumps too large for the conveying system, and it is advantageous that it be removable. Figure 3 shows a good design. The three grid sections rest on the top flanges of the track girders and side curb angles. Any section may be lifted out if it should be necessary to clear an accumulation in the hopper.

Grids and screens have other functions in coal handling installations. In the well-known Bradford breaker, perforated plates serve to pass the coal through and to cull out rags, wood, hay, and unbreakable lumps. In loading a belt conveyor, a bar-grid serves to form a blanket or cushion and soften the impact of the bulk of the load. Where the space between, or the depth of the grid bars tends to cause binding, the bars may be of triangular cross section.

How to Retard Flow in Chutes

Long chutes sometimes are not too good, as from the head of an elevator out to reserve storage. Dry coal will flow readily on a chute inclined at 38 deg or flatter; but with damp coal a steeper slope is necessary, so it has long been standard practice to use a 45 deg slope. This means that much of the time the coal is chuting down at high velocity, scattering clouds of dust as it strikes the ground. It is easy to retard the flow on a chute too steep by cross angles, which cause the coal to cascade and slow down. It is not so easy to correct a chute too flat. The cross angles might be made adjustable to suit the flowability of the coal, but adjusting them would be a

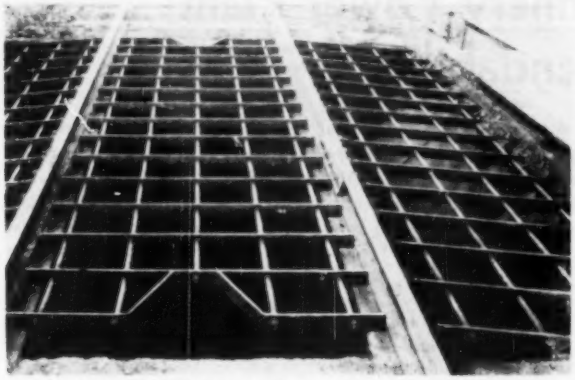


Fig. 3. Removable track hopper grid over 12 ft by 12 ft track hopper, part of a Peck carrier coal and ash handling system at Barry & Stames Linoleum, Ltd., Canada. Installed 1931, this view 1937. A grid of this type serves not only to cull out oversize lumps and debris but also reduces risk of injury to men

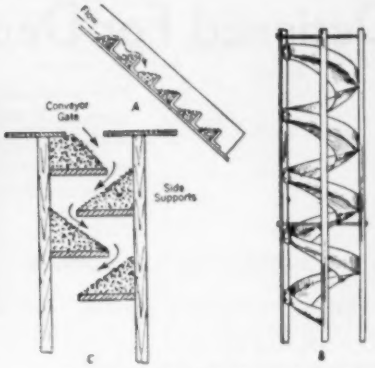


Fig. 4. Various types of retarding chutes A—Baffles retarding flow along a chute too steep; B—Spiral retarding chute; C—"Coal ladder," a vertical retarding chute

Hoppers for Coal-Handling Systems

nuisance. As an alternative to a long chute, an overhead conveyor with spaced short discharge chutes, extending out far enough from the boiler house so the nuisance from dust is slight, is worth considering.

Kinds of Bunker Gates to Use

Bunker gates usually are the undercut swing type with the cut-off across the flow. In the smaller sizes the single-leaf gate, Fig. 5A, is satisfactory but as the width of opening becomes larger the double-leaf gate, Fig. 5B, is preferred, with the swing of the leaf reduced by 50 per cent. Since there must be a definite height allowance to accommodate the gates, the sliding plate type, Fig. 5C, sometimes is preferred because every inch saved in gate height means a corresponding reduction in the height and cost of the building structure. A 24-in x 24-in duplex undercut gate has a depth of about 27 in. The same size sliding plate gate has a depth of 6 in. With lumpy coal, a sliding plate has the objection that lumps may lodge between it and the gate body. Gates serving a larry are operated frequently and the quick-acting undercut type is best. Gates serving stoker or pulverizer chutes are operated infrequently and the sliding type is suitable.

Feeders

Feeders of the reciprocating plate type have long been standard although they have the disadvantage that the feed stops when the track hopper is about half emptied. The apron feeder has the advantage that it may have indefinite length and may incline upward as steeply as 25 deg or so, and the disadvantage that it dribbles coal along the return run. The trend is toward the electromagnetic vibrating feeder like the Syntron or the Traylor, the latter shown in Fig. 6. The power requirement is remarkably low—about 2 hp for a feed of 500 tph and proportionally less for smaller capacities. The rate of feed may be adjusted while the feeder is operating and there are no moving parts requiring lubrication. The movement of the plate is imperceptible except for a slight blurred appearance. Its limitation is with coal so wet that the water squeezes out, causing a build-up—a condition unlikely in actual practice.

The items we have discussed are not major items in the engineering of a coal-handling layout, but they are of interest because so frequently an installation otherwise well designed, with quality machinery equipment, is hastily judged, or misjudged, because of one or two of these "minor" features.

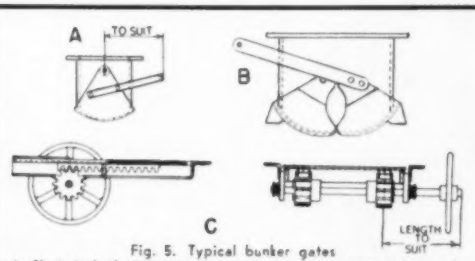


Fig. 5. Typical bunker gates
A—Single-leaf pivoted gate; heavy to operate by hand, but may be counterweighted; best for openings not larger than 12 in. by 18 in. B—Double leaf pivoted gate; suitable for larger openings than A, for leaves are geared together and swung by single lever or geared for power operation. C—Sliding-plate gate has advantage of minimum height to save building height

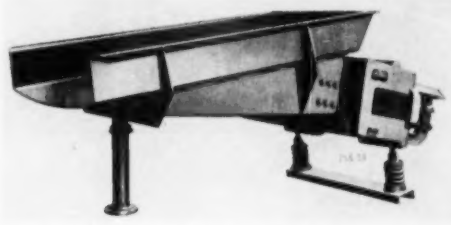


Fig. 6. Jeffrey-Traylor electric vibrating feeder operates on either a-c or pulsating d-c. Feed readily adjusted by changing slope slightly, or by changing intensity of magnetic impulses

New European Refinery Power Plant Designed For Dependability

New power plant for the Caltex oil refinery at Rotterdam, Holland, is an excellent example of high-grade post-war development in Europe . . . Built of 100 per cent American equipment, this plant operates at 550 psig, 750 F, and supplies steam, water service and compressed air for all refinery operations . . . Novel feature of the plant is the use of two 48-in. syphons to avoid breaching a dyke, supplying cooling water

By C. J. RUZICKA* and R. R. POPHAM**

ONE OF THE FIRST complete refineries to be built in post-war Continental Europe is now approaching completion. It is situated on the Maas River near Rotterdam, Holland. The refinery is being built for Caltex Petroleum Maatschappij, and is designed to process 20,000 barrels per day of crude oil. The refinery will produce gasolines, kerosenes, Diesel gas oil and other fuels which will be distributed by Caltex affiliates in Holland, Belgium, Luxembourg, and perhaps those parts of Switzerland which can be reached through the Rhine River. Due to the war and the resultant disruption of manufacturing facilities in Europe, practically all equipment was obtained in the United States.

Early investigations indicated the desirability of utilizing local electrical power and fresh water supplies, and showed that all steam and other utilities should be produced within the refinery. The boiler house installation consists of two 150,000 lb per hr steam generators designed for output conditions of 550 psig at 725 F, plus the necessary boiler auxiliaries, hot process type water softeners, refinery instrument and service air compressors, and the condensate-feedwater heat recovery system. The general arrangement of the plant is shown by Figs. 1 and 2.

The high pressure steam is used for large steam driven auxiliaries, and for make-up to the 150 psig system through the desuperheating-reducing station. Steam at 150 psig is required for process work and for driving the majority of the steam-driven auxiliaries. Large mechanical drive turbines exhaust to the 150 psig steam system, and process plant waste heat boilers generate steam at 150 psig to provide the bulk of the steam requirements at this pressure, with any extra needs being satisfied by the 550/150 psig reducing station. With the few exceptions indicated, all auxiliaries exhaust at 20 psig to a refinery header. This steam is used in turn for process heat exchangers, boiler feed preheating and general building and tankage heating.

The refinery cooling water supply is furnished by two 18,000 gpm vertical hi-lift cooling water pumps driven by 680 hp steam turbines through right angle gear reducers. These pumps are installed on the bank of the Maas River in a separate pump house. The turbine drives for the pumps are mixed pressure, bleeder condensing type. Steam at the throttle is 550 psig 725 F and 20 psig steam can be either bled or inducted. This is the refinery heat balance "flywheel" and it is calculated that it will not be necessary to waste 20 psig steam at any time. To avoid breaching a dyke, and to reduce the introduction of silt, the cooling water supply was taken by two 48 in. siphons from the river to the pump house forebay. Constant evacuation of the siphons will be ensured by automatically controlled vacuum pumps.

Dependability and continuity of service are of prime importance in an oil refinery boiler house where the demand for steam is uninterrupted through the year, and a complete shutdown of the plant is to be avoided if possible. As will be seen from Fig. 3, the plant was laid out with two high pressure steam headers, duplicate boiler feed headers, and the necessary interconnections to permit repairs on any piece of equipment, valve, or section of piping without interruption of services to the refinery.

The two boilers are arranged for burning either fuel oil, refinery waste gas, or a combination of both. The combustion control is set up so that all of the refinery waste gas available is burned providing the

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Architect's drawing of the new Rotterdam power plant and refinery of the Caltex Plant in Holland

steam demand is sufficient. If the steam demand is insufficient to dispose of this gas, a pressure relief valve in the refinery relieves the excess gas to a flare. If the refinery gas is not available in sufficient quantity to satisfy the steam demand, fuel oil is automatically fed to the combination burners to provide the required heat input. The correct amount of air for combustion depends upon the relative proportions of fuel oil and gas burned in the boiler, and the combustion controls are arranged to automatically compensate for changes in this ratio.

The forced and induced draft fan for each boiler is on a common shaft, and is driven by a geared turbine. Turbine speed is adjusted by combustion requirements to control the speed of the forced draft fan. Additional automatic dampering of the induced draft fan balances the draft. In order to minimize corrosion at the cold end of the tubular air preheater, warm air is recirculated from the discharge of the preheater to the suction of the forced draft fan. An additional 10 per cent forced draft fan capacity was found adequate to maintain the minimum desired metal temperature at the entrance to the air heater.

The fuel oil system (see Fig. 5) is arranged for utmost dependability. There are two motor driven pumps, and one turbine driven pump. One motor driven pump supplies the refinery process furnaces, while the other pump serves the boiler house. As shown in Fig. 5 the steam driven pump is a spare serving either of the motor driven units. This pump starts automatically upon fuel oil pressure failure. The boiler house is served by three fuel oil headers, one being a supply header and one a return header. The third header is a spare, and is valved so that it can operate as either a supply or return header. A constant oil pressure is maintained in the supply headers by means of back pressure valves.

One fuel oil heater is normally used for the boiler plant, and one heater is used for the process furnaces, although either heater can be used for both services when the other is taken out of service. Either 150 psig or 20 psig steam can be used for heating thus providing two sources of heat for dependability. Also if it is not possible to shut down a heater for a scheduled cleaning, the use of 150 psig steam will allow the heaters to be used for a longer period.

The hot process water treatment plant includes two separate units which are practically identical. These units are piped for two stage operation, and one shell is utilized as the first stage or hot lime soda treater, and the second shell is utilized as a hot phosphate treater. Under normal conditions the plant is operated

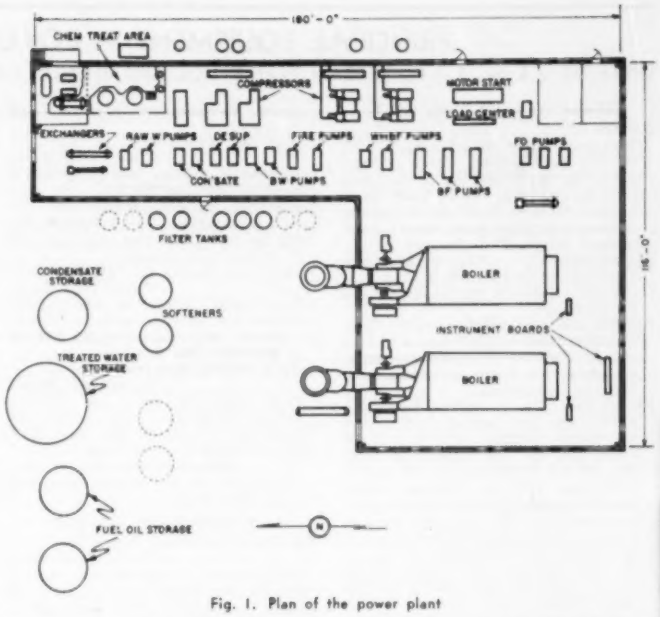

Fig. 1. Plan of the power plant

as a two stage water conditioning unit with resulting small boiler sludge accumulations and blowdowns. If maintenance or repairs are required on either shell or the connecting piping, one unit can be shut down and the plant operated as a single stage hot lime-soda treating plant, with the phosphate injected directly into the boiler drums. Under these emergency conditions the plant still has effective water conditioning, but the boiler blowdown must be increased temporarily to remove the extra sludge. In other respects the water treating plant is conventional with anthrafilt filters, sludge pumps, backwash pumps, and chemical feeding equipment.

The returned condensate from the refinery may be contaminated with varying amounts of oil from leaky heat exchangers or reciprocating pump exhausts, and oil removal filters were installed to remove this oil. In operation, preformed floc is injected into the entering oily condensate line, and the oil is absorbed by the floc. The oil bearing floc is then removed in passing through the

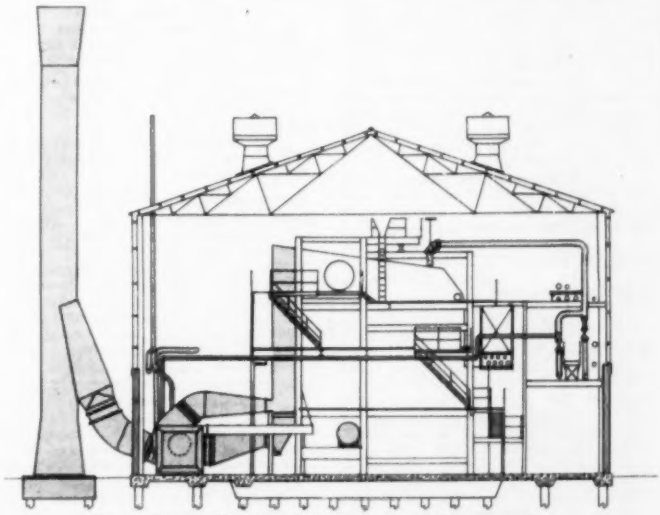

Fig. 2. Cross section through the Rotterdam Caltex power plant

PRINCIPAL EQUIPMENT IN BOILER HOUSE

UNITS No. 1 & No. 2 — ROTTERDAM (PERNIS) HOLLAND REFINERY CALTEX PETROLEUM MAATSCHAPPIJ

STEAM GENERATING UNIT

BOILERS (2) ..... Riley Stoker Corp. Two drum water cooled furnace with 16" OD front header. Rated at 150,000 lb per hr, 190,000 per hr for short periods, 550 psig, 725 F, 6,100 cu ft furnace volume, 15,300 sq ft heating surface (including water walls). Four refinery gas-fuel oil burners.

SUPERHEATERS (2) ..... Riley Stoker Corp. 27 elements approx. 130 ft long, 2¼" OD. No superheat control for present installation.

AIR HEATERS (2) ..... Riley Stoker Corp. Tubular type, single pass, 2½" OD tubes, 13,500 sq ft heating surface. Arranged for hot air recirculation back to fan suction.

FD-ID FAN (2) ..... Buffalo Forge Co. FD-ID fans on common shaft driven by steam turbine. FD fan 57,400 CFM, 11½" SP, 110 F, 1185 rpm, 172½ hp. ID fan 96,000 cfm 9" SP, 455 F, 1185 rpm, 201 hp. Turbine driver speed automatically controlled by requirements of FD fan with supplementary dampering of ID fan.

FAN DRIVERS & GEAR REDUCERS (2) ..... International Gen'l. Electric Co. 375 hp each, 550 psig, 725 F, 20 psig back pressure, gear reducer 6000 to 1185 rpm at rated hp. Air motor on turbine governor for combustion control.

SOOT BLOWERS ..... Diamond Power Specialty Corp. Straight line type operating at 550 psig and 725 F.

WATER COLUMNS (2) ..... Diamond Power Specialty Corp. Each column with two bi-color gages, one gage equipped for remote reading.

BOILER STACKS (2) .. Buffalo Tank Corp. 6'-6" diam. x 80'-0" high, insulated to prevent condensation.

FUEL HANDLING SYSTEM

FUEL OIL PUMPS (3) ..... Dravo Corp. (De Laval) Two motor driven and one turbine driven. 100 gpm, 150 psig, 120 F. One pump serves boiler house, one pump serves process furnaces, turbine driven pump spares either service

FUEL OIL HEATERS (2) ..... American Locomotive Co. Floating head, 100 gpm oil on shell side (single pass), 15/16" square tube pitch, 505 sq ft surface, duty 2,420,000 Btu per hr. 20 psig or 150 psig steam.

FUEL OIL TANKS (2) ..... Bethlehem Steel Export Corp. 15'-0" diam. x 18'-0" high cone roof type. (500 bbls)

FUEL OIL TANK HEATERS (2) ..... Brown Fintube Co.

FUEL GAS HEATER (1) ..... Brown Fintube Co.

FUEL GAS KNOCKOUT POT (1) ..... L. O. Koven & Brother Inc.

FEEDWATER SYSTEM

HOT PROCESS WATER TREATERS (2) ..... Liquid Conditioning Corp. Two stage hot lime soda—hot phosphate; two separate identical units with separate sludge pumps and all accessories. Three hot process filters, two oil removal filters; lime soda phosphate and floc feeding equipment, two backwash pumps. Capacity 200,000 lb per hr of deaerated treated water and condensate with 20 psig steam. Maximum treated water 77,500 lb per hr.

BOILER FEED PUMPS (3) ..... United Iron Works Horizontal, 4-stage, 400 gpm, 1560 ft head at 3800 rpm, 259 F.

BOILER FEED TURBINE DRIVERS (3) ..... International Gen'l Electric Co. 192 hp each, 3800 rpm, 550 psig, 725 F, 20 psig back pressure.

WASTE HEAT BOILER FEED PUMPS (2) ..... United Iron Works One motor driven & one turbine driven for process furnaces. Horizontal, 2 stage, 125 gpm, 555 ft head at 2900 rpm, 259 F.

CITY WATER MAKEUP PUMPS (2) ..... United Iron Works One motor driven & one turbine driven. Horizontal, end suction, 200 gpm, 172 ft head at 2900 rpm, 40 F.

TREATED WATER STORAGE TANK (1) ..... Bethlehem Steel Export Corp. 25 ft diam. x 24 ft high cone roof type (2000 bbls).

CONDENSATE SYSTEM

REFINERY CONDENSATE PUMPS (2) ..... United Iron Works One motor driven & one turbine driven. Horizontal, end suction, 200 gpm, 61 ft head at 1460 rpm & 200 F.

CONDENSATE PUMPS (2) ..... United Iron Works 240 gpm, 122 ft head at 2900 rpm, 160 F.

REFINERY CONDENSATE EXCHANGER (1) ..... American Locomotive Co. Fixed tube sheet, 150,000 lb per hour condensate thru shell, 150,000 lb per hr raw water thru tubes, duty 7,950,000 Btu per hr, 585 sq ft furnace.

REFINERY COND. VENT CONDENSER (1) ..... American Locomotive Co. Floating head, 150,000 lb per hr raw water thru tubes, 7250 lb per hr steam condensed, duty 7,050,000 Btu per hr, 620 sq ft surface.

CONTINUOUS BLOWDOWN EXCHANGER (1) ..... The Griscom Russell Co. Floating head, 11,220 lb per hr of continuous blowdown, 155,000 lb per hr of raw water thru tubes, duty 646,000 Btu per hr, 122 sq ft surface.

REFINERY CONDENSATE RECEIVER (1) ..... Midwest Piping & Supply Co., Inc.

CONTINUOUS BLOWDOWN TANK (1) ..... Midwest Piping & Supply Co., Inc.

CONDENSATE STORAGE TANK (1) ..... Bethlehem Steel Export Corp. 15'-0" diam x 18'-0" high cone roof type (500 bbls).

MISCELLANEOUS

PLANT AIR COMPRESSORS (2) ..... Worthington Pump & Mach'y. Corp. Duplex horizontal 19½" x 12" x 12" 1683 cfm, 110 psig discharge pressure, 5-step capacity control, intercooler, aftercooler and receiver. Westinghouse 200 hp, 3000 v, 50 cycle, 3 phase synchronous motor with 7½ hp, 380 volt MG set and magnetic full voltage compressor starter.

INSTRUMENT AIR COMPRESSORS (2) ..... Worthington Pump & Mach'y. Corp. Single, horizontal 17" x 13", 794 cfm, 50 psig discharge pressure, bypass control, aftercooler & receiver. General Electric 125 hp, 3000 Volt, 50 cycle, 3 phase synchronous motor with 5 hp, 380 Volt MG set and magnetic full voltage compressor starter.

EMERGENCY TURBO-GENERATOR (1) ..... Terry Steam Turbine Co. 15 kw, 400/230 v, 3 phase, 4 wire, 50 cycle. 150 psig, 450 F and 20 psig back pressure.

TURBINE DRIVEN FIRE PUMP (1) ..... Ingersoll-Rand Co. Horizontal, single stage, 750 gpm & 150 psig discharge.

MOTOR DRIVEN FIRE PUMP (1) ..... United Iron Works Horizontal, single stage, 750 gpm & 150 psig discharge.

DESUPERHEATER PUMPS (2) ..... Union Steam Pump Co. 7½" x 4" x 6" horizontal reciprocating, 30 gpm, 225 psig discharge, 150 psig, 450 F and 20 psig back pressure.

EMERGENCY INSTRUMENT AIR COMPRESSOR (1) ..... Westinghouse Air Brake Co. 8½" vertical reciprocating, single stage with receiver. 150 psig, 450 F and exhausting to atmosphere.

INSTRUMENT AIR DRYER (1) ..... The Davison Chemical Corp. 750 scfm Silica Gel Dehydrator type with dual Towers for continuous operation, semi automatic.

150 PSIG TURBINE DRIVERS (5) ..... Dean Hill Pump Co. For fuel oil pump, waste heat boiler feed pump, fire pump, city water makeup and refinery condensate pump. 150 psig, 450 F, and 20 psig back pressure. 5 to 65 hp.

SUMP PUMP (1) ..... Aurora Pump Co. Duplex, 600 gpm, 10 ft head, 3 hp, 50 cycle, 380 v.

VALVES & PIPING

FABRICATED PIPING .... Midwest Piping & Supply Co., Inc.

BOILER BLOWDOWN VALVES ..... Yarnall-Waring Co.

BOILER STOP CHECK VALVES ... Crane Co.

STEEL VALVES ..... The Chapman Valve Mfg. Co.

IRON VALVES ..... Wm. Powell Co.

EXPANSION JOINTS ..... E. B. Badger & Sons Co.

EXPANSION JOINTS ..... Chicago Metal Hose Corp.

STEAM TRAPS ..... Armstrong Machine Works

INSTRUMENTATION

COMBUSTION CONTROL .. Bailey Meter Co.

FEEDWATER REGULATION ..... Bailey Meter Co.

PRESSURE REDUCING & DESUPERHEATING STATION .... Republic Flow Meters Co.

FLOW METERS .. Brown Instrument Co.

TEMPERATURE & SALINITY RECORDER ..... Brown Instrument Co.

LIQUID LEVEL CONTROLLERS ..... Fisher Regulator Co.

PILOT OPERATED CONTROL VALVES ..... Mason-Neilan Regulator Co.

CONTROL VALVES . The McAlear Mfg. Co.

BOILER SAFETY VALVES ..... Manning, Maxwell & Moore, Inc.

RELIEF VALVES ..... Farris Engineering Corp.

ELECTRICAL EQUIPMENT

200 HP, 3000 V, SYNCHRONOUS MOTORS (2) ..... Westinghouse Electric Corp.

125 HP, 3000 V, SYNCHRONOUS MOTORS (2) ..... General Electric Co.

MOTOR GENERATOR SETS (4) ..... Westinghouse Electric Corp.

3000 V and 380 V LOAD CENTERS ..... Westinghouse Electric Corp.

filter beds. When the pressure loss across a filter becomes excessive, it is backwashed using the same pumps used for the hot process filters. The filters are equipped with rotary surface washers which agitate the top of the filter bed, and aid in the backwashing. After backwashing, floc is fed into the filter bed to precoat the filtering media, following which the filter is ready for service again.

In the design of the condensate recovery system the value of recovered heat was balanced with the cost of additional heat transfer surface. As shown in Fig. 4, the returned 20 psig condensate returns to the flash tank in a small basement in the boiler house which permits most of the condensate to return by gravity. The flash above 212 F passes to a vent condenser where it is condensed by entering make-up feedwater, and the non-condensables are vented to the atmosphere. The condensate is pumped from the flash tank through a refinery condensate exchanger where additional heat is given up to the make-up feed system, and then passed to an insulated surge and storage tank. The condensate is finally returned to the boiler feed system through the oil removal filters and then through the deaerating sections of the water treating units. The boiler make-up feed supply is taken from a local municipal water system, and passed through the refinery condensate exchanger, the refinery vent condenser, and the boiler continuous blowdown exchanger in succession before being subjected to the hot-process treatment.

Two duplex, horizontal plant air compressors supply service air for the entire refinery. Each compressor is rated at 1063 scfm (cfm of air at standard conditions) and 110 psig discharge pressure, and is driven by a 200-hp synchronous motor with a separate 7½-hp motor driven exciter set. One compressor will carry the entire refinery load plus some reserve for future requirements. Five step capacity control allows flexibility for varying loads.

Two single stage horizontal air compressors supply instrument air for the entire refinery including the boiler house. Each compressor is rated at 794 scfm and 50 psig discharge pressure, and is driven by a 125 hp synchronous motor with a separate 5 hp motor driven exciter set. One compressor will carry the entire refinery load plus some future load, and bypass control allows flexibility for varying loads. Emergency supply to the 50 psig instrument air system is obtained through an automatic pressure reducing valve from the 110 psig service air system. To insure an instrument air supply to the boiler house under any possible conditions, an emergency steam driven air compressor is installed so that if the instrument air pressure drops for any reason, the steam driven compressor automatically cuts in. This compressor is sized for the boiler house instrument air load only.

A silica gel instrument air dryer with dual towers dries all instrument air supplied to the refinery and boiler house. This unit is semi-automatic and the silica gel in one tower is reactivated while the other tower is in service. This air dryer reduces the dew point of 750 scfm from 70 F to -30 F.

The entire boiler house and auxiliary pump bay is supported on reinforced concrete piles. The equipment and boiler house foundations are of reinforced concrete beam and slab construction. The pump bay area consists of a flat structural slab topped by a 14 in. sand fill and a 4 in. finished floor slab which permits the installation of pipe trenches and conduit runs where necessary. Large compressor foundations are isolated from the building foundations and batter piles are used to minimize vibration. Foundations for small pumps, turbines and miscellaneous equipment are placed directly on, and anchored to the structural slab.

A separate electrical sub-station has been installed in the yard which is supplied by dual 25,000-v-50 cycle feeders from the local municipal system. This voltage is reduced to 3000 v and 380 v for distribution to the process plants as well as to the two load control centers centrally located in the boiler house. The 3000-v load control center contains the starting equipment for the large compressor synchronous motor drives, while the 380-v load control center supplies power for the smaller auxiliaries. Near the load centers a 15-kw lighting turbo-generator has been installed to provide emergency lighting to the entire refinery in case of failure of the purchased power. This generator starts automatically upon failure of the general power supply, or upon the failure of power supply to any individual process plant. In case of such localized failure, only the plant or plants affected are thrown on to the emergency lighting supply by means of an automatic throwover switch. This emergency lighting supply is installed to permit an orderly shut-

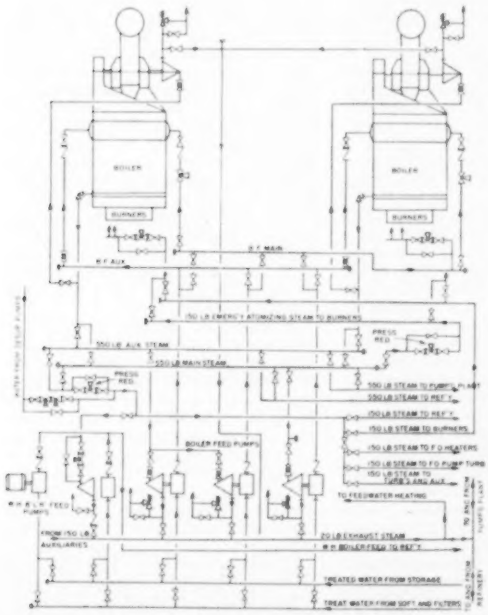

Fig. 3. Flow diagram, steam and boiler feed water

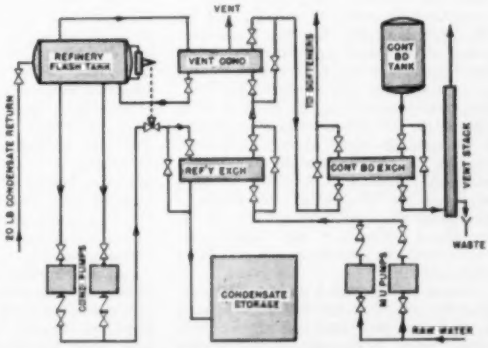

Fig. 4. Flow diagram of the condensate system

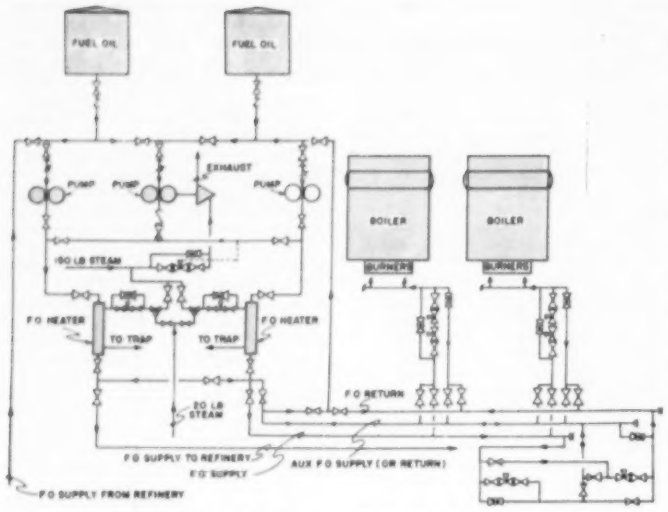

Fig. 5. Flow diagram of the fuel oil system

down of the process units in case of electrical power failure. To permit the boiler house to continue to operate, the control instrument boards as well as selected lighting circuits are supplied with emergency electrical power, and all essential pumps normally electrically driven have steam driven spares.

An annunciator system is installed in the boiler house, and is arranged to notify the operator of any abnormal conditions such as low boiler feed pressure, low water levels in the water treating units, failure of instrument air and service air supplies, and sub-station faults.

As can be seen from the foregoing, a refinery utility system represents an interesting balance of plant economics against the requirements for maximum service and dependability. Since a utility supply failure affects all processing units, dependability must be stressed in all phases of design, while at the same time investment costs must be governed by the same economic factors that apply to the refinery as a whole.

The Thermoelectric Generator

Further investigation into the problems involved in designing a practical thermoelectric generator indicate great difficulties but none so great that they do not offer methods of solution

IN THE AUGUST 1949 ISSUE we presented an article by Curtiss D. Bassett outlining certain ideas which might be incorporated in the design of a practical thermoelectric generator—one capable of delivering considerable quantities of electric power directly from the combustion of fuel. This proposed thermoelectric generator was unique in that it made use of a new type of thermocouple, a thermocouple made of silicon carbide and carbon. This type of thermocouple is actually being used in the steel industry for the measurement of temperature of molten steel. Its high electromotive force—300 microvolts per degree Centigrade—is so very much higher than that of the usual metallic thermocouple, that it seemed to offer attractive possibilities in the design of a thermoelectric generator. Another attractive feature of this thermocouple is the fact that silicon carbide is an excellent refractory, one capable of withstanding extremely high temperatures.

From a purely thermodynamic standpoint, the use of this silicon carbide-carbon thermocouple indicates very high efficiencies as an energy conversion device, efficiencies far above the usual Rankine cycle efficiencies obtained in present-day, high-pressure, high-temperature steam-electric generating stations. All this was fully covered in the article in the August issue.

On the basis of his preliminary studies, Mr. Bassett continued his investigations with a view of working out the detailed design of a large, practical, thermoelectric generator, one capable of delivering, say, 5000 kw.

Further investigation and detailed analysis soon disclosed obstacles that had not been given too much thought in the initial stage of the work, though they were not unsuspected. One of these was the problem of heat transmission through the thermocouple to the cool junction. The effectiveness of a thermocouple, of course, is a function of the temperature difference between the hot and the cold junction. Despite the fact that silicon carbide is a relatively poor conductor of heat, analysis indicated that the heat flow through the thermocouple would be sufficient to so heat the cool junction as to make a simple scheme impractical.

In the meantime, Mr. Bassett's article had created considerable interest on the part of many who had read it, several of whom felt that the heat conduction through the thermocouples might prove troublesome. Maria Telkes of the Massachusetts Institute of Technology directed attention to the work that had been done at MIT of the subject and Howard I. Podell of New York commented on the article in great detail; his comments are presented here. Among several suggestions Mr. Podell made was a very interesting idea for building an *alternating-current* thermoelectric generator. Startling as this suggestion may appear on first thought, it is not too impractical to warrant serious consideration. This alternating current generator has inherent in it certain features which would, to some extent, mitigate the heat transfer problem.

In short, Mr. Bassett's article has resulted in a whole category of new ideas on the subject and while the practical thermoelectric generator is still a long way off there is sufficient merit in these ideas to warrant further investigation. Indeed, Mr. Bassett's article has already resulted in research to determine the Thomson Effect Coefficient for silicon carbide and for graphite. This is being undertaken at the North Carolina State University.

Below, we present, first, Mr. Podell's comments on Mr. Bassett's article and then, another article by Mr. Bassett describing his more recent investigations. Editor.

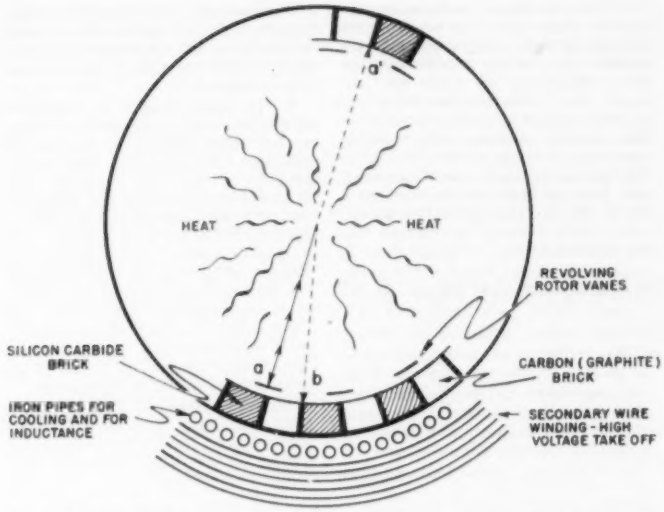

Fig. 1. Diagram showing the principle of the alternating-current thermoelectric generator Note: The heat is reflected from junction at a and is reflected to junction at a'. Spacing of openings in rotor vanes is designed for generation of polyphase current so as to utilize the heat which is reflected

Discussion By Howard I. Podell

THE DISCUSSION OF thermoelectric generators by Mr. Curtiss D. Bassett in last August's issue of POWER GENERATION is quite thought provoking. The high temperatures available in the atomic pile require conversion into power in a manner not employed at present.

It is in the thermoelectric and possibly photoelectric generator that the atomic power engineers may find an efficient converter of power at high temperatures. All our stocks of existing fuels have been obtained by a photoelectric process and at low ambient temperatures, viz. the conversion of CO_2 to carbon and cellulose in plant life. The mechanism of the vegetable process which utilizes the radiant energy of the sun is still inexplicable today.

It seems a little unfair to criticize a general review such as Mr. Bassett's by commenting on specific details which may have been omitted for the sake of clarity, but there is one feature of the thermoelectric generator which has always deterred actual operation. That feature is the need for keeping one junction cold, with the other hot, and yet maintaining a firm electrical connection between the two.

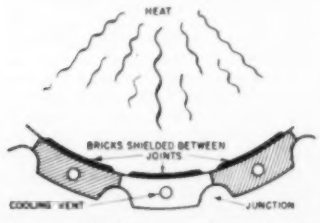

Fig. 2. Detail of thermocouple construction

Inasmuch as each thermocouple generates a low voltage, the IR drop across each of the two electrical conductors in series cannot be more than a few millivolts. The heat from the hot junction is transmitted in parallel through each of the two conductors, and since the conductors must be large to avoid electrical resistance, the amount of heat transmitted to the cold junction will also be large.

All of the heat reaching the cold junction must be removed by cooling. If the cold junction is to be kept at 100 F as Mr. Bassett suggests, this cooling operation will require refrigeration, since there is too small a temperature differential to work with, using air at ambient temperatures.

The choice of graphite and silicon carbide is an excellent one. They are most suitable since they are each better conductors of electricity than of heat. But the amount of heat which will require cooling at 100 F would undoubtedly demand greater energy in refrigeration than the system could produce in power.

Furthermore, the cooling of the cold junctions must be uniform, and disparity must be allowed for in the original design. Thus if the average temperature of the cold junctions of one thermopile is 90 F and of another, 200 F, the former pile will generate a higher voltage, and feed back through the latter, since both are in parallel. This could be compensated for in the original installation by installing more thermocouples in the latter pile.

An A-C Thermoelectric Generator

Perhaps it might be interesting to consider the possibility of designing an alternating current thermoelectric generator. While presenting problems of its own, which are solvable, it does remove many of the disadvantages of the direct current generator.

A most important advantage of an alternating current generator would be the fact that the generation of low-voltage, high-current power could be transformed using a secondary winding around the alternator into easily handled high voltage power with which we are most familiar. There would be no necessity for drawing the low voltage out of the generator, and there would be no direct contact between the thermocouples and the outside conductors.

Furthermore the cooling process could be maintained at a temperature differential of as much as 1000 F or greater. With such a differential, cooling processes are economical and in fact are capable of producing power themselves efficiently.

What is perhaps most important, the length of conductors between the "hot" junctions and the "cold" junctions could be reduced to negligible dimensions eliminating IR drop. A greater number of thermocouples could be used.

The thermopiles of an alternating thermoelectric generator would consist of rings of bricks. Each ring would be made up of graphite blocks interspersed between silicon carbide blocks. Cooling, instead of being directed at cold junctions, would be concentrated at the midsection of bricks. The cooling could be achieved by vertical holes through the brick, by radiation and by blasts of air applied to both the inside and the outside surfaces of the bricks.

Instead of attempting to maintain the cold junction of a specific temperature the purpose would be to maintain a temperature differential of say 500 F, between junctions.

The alternating thermoelectric generator requires a rotation of the source of heat, or more practically, rotating vanes between the bricks and the source of heat. While the vanes themselves could be cooled internally, they would operate at a very high temperature and be designed of refractory material. The purpose of the vanes would be to permit heat radiation between alternate junctions.

The frequency of the electric current produced would be a direct function of the speed of the rotating vane. The optimum speed would depend on the heat flow characteristics of the bricks.

Under ideal circumstances, the

rotor would permit one set of junctions to heat up 250 F while the adjacent shielded junctions lost 250 F to the cooling system. During phase 2, as the heat source revolves between the two junctions, the hotter junction would lose heat to both the cooling system and the colder junctions, equalizing their temperatures again. Phase 3 would consist of the heat source now directed at the previously "cold" junction reversing phase 1. The current would now flow in the opposite direction.

The maximum operating temperature would be determined by the resistance of the vane material. The alternator would be most practical for high temperatures since greater temperature differentials would exist between junctions, thus generating greater voltages. Since the cooling system efficiency is critical, the higher temperatures would also permit higher efficiencies.

It is not necessary to consider generation of secondary power from the cooling system, except possibly the power required for its own circulation, where nuclear fuels are utilized. But it may be considered that where combustion is the heat source, the cooling system will probably generate as much as 50 per cent of the power normally available from the fuel, in addition to that produced by the thermoelectric generator. And it must be realized that the electric power produced directly represents power which is completely usable and not subject to the entropy losses associated with converting steam into motive power.

The writer is not going to attempt to go into all the refinements of design necessary for an efficient alternating current thermoelectric generator. Its design is suggested primarily for two reasons:

1. To eliminate low temperature cooling which is inefficient and substitute high temperature cooling which is power productive and requires less volume of coolant per heat removed.

2. To reduce length of conductors of the low voltage circuit to a minimum. This reduction of length also reduces the necessary area cross-section of the low voltage conductors, which in the alternator are entirely self-contained, making a smaller installation possible.

The secondary advantages of an alternator include the ability to take off high-voltage low-current power, requiring smaller converters (for frequency changing if necessary), and eliminates the need for any mechanical generators at all if the output is at a useful frequency.

The advantages of the alternating generator also increase with the temperature used permitting the higher temperatures obtainable with nuclear energy.

Problems Encountered in Thermoelectric Generator Design

C. D. BASSETT, Mechanical Engineer

THE GREATEST OBSTACLE in the path of the successful design of an efficient thermoelectric generator of the type discussed in Ref. 1 is the fact that conductors connecting each hot junction with its cold junction not only are conducting electricity but also they are conducting heat. The amount of heat conducted increases, of course, as the temperature difference between the two junctions is increased.

Thus a combination of great temperature difference between the junctions and the great number of individual thermocouples required to produce any appreciable power thermoelectrically can result in a simply enormous heat loss at the cold junction due to conduction. This situation is aggravated by the need for low electrical resistance in the conductors of the generator. Thus unless some special technique is employed to minimize or prevent this heat loss, the efficiency of any thermoelectric generator will be very very low.

At least four special techniques have been investigated with an eye to circumventing the staggering heat losses due to conduction.

With one method, admirably described in Ref. 2, it was found that efficiencies in excess of 5 per cent could be obtained with thermocouple materials to which the Wiedemann-Franz-Lorenz relation is applicable, providing their thermoelectric power is greater than 200 microvolts per degree Centigrade. The Wiedemann-Franz-Lorenz relation states that the ratio of the heat conductivity to the electrical conductivity is a constant for all materials. It is applicable to most metals and alloys and, as Ref. 2 points out, to some metallic sulfides and oxides. At any rate this method indicates that, for higher efficiency, materials must be developed which exhibit in combination high values of thermoelectric power, low heat conductivity, and low electrical resistance.

The writer, in conjunction with Mr. F. Dengiz, mechanical engineer, investigated in detail two engineering techniques for improving the efficiency of thermoelectric generators. These techniques seek to use rather than waste the conducted heat. They do not seek any special property in the thermocouple materials.

The first of these methods was suggested by Mr. Howard I. Pedell, mechanical engineer. Its main idea is to use a very high cold junction temperature, so that the cooling air coming from these junctions can be employed to do further work. The idea is thus similar to that of the mercury-steam boiler in which work is first extracted from the mercury vapor which is then condensed by a steam boiler, the steam in turn generating its block of energy.

Thus if the hot junction temperature of a thermoelectric generator be 2700 F and the cold junction temperature, 1000 F, a definite amount of electrical power may be extracted from the generator depending upon its size. Cooling air comes from the cold junctions at 1000 F and is mixed with the hot gases, the products of combustion, coming from the furnace at 2700 F. The combined flow is then fed to a gas turbine, for instance, at the temperature of the mixture, 1500 F. Another block of power is obtained from the gas turbine.

The exhaust gases therefrom, at a temperature of about 1000 F, then pass through a preheater to heat the combustion air on its way to the furnace. It is here that this particular technique breaks down after coming this far with high hopes. The ratio of the exhaust gases to the combustion air is so great that the latter cannot absorb a very large block of heat in the preheater. Even though the combustion air can leave the preheater at 1000 F, the exhaust gases will go to the stack at over 900 F, carrying a tremendous amount of heat with them.

For 5000 kw generated by the particular combination discussed above a thermal efficiency, coal pile to switchboard, of not over 19 per cent can be obtained.

The second of these methods, suggested by Mr. F. Dengiz, is quite unique and unusually ingenious. This idea starts with a certain design value of heat loss by conduction, say 2 or 3 per cent, from the cold junctions at 100 F. The hot junction temperature is taken to be 300 F, for example. From this thermoelectric generator is taken a certain increment of the total electrical energy.

This generator receives its heat by radiation to its hot junctions from the cold junctions of an adjacent thermoelectric generator operating at higher temperatures. Its cold junction temperature is such that it will radiate to the lower temperature generator heat equal to the power generated by the colder gen-

erator plus the heat conducted through the colder. It in turn receives heat by radiation from a third adjacent generator operating at still higher temperatures, larger by the increment of electrical energy it will produce than the amount of heat it delivers to the colder generator.

Thus can be employed a sufficient number of these thermoelectric generators each radiating a smaller and smaller amount of conducted heat or, rather, each in turn extracting its increment of power from the conducted heat until there is left only the design value of 2 or 3 per cent conducted heat loss out of all the heat introduced at the hottest of all the hot junctions. The rest of the conducted heat has been converted to electrical energy.

To develop 5000 kw by this method the initial hot junction temperature would need to be somewhat over 15,000 F! To help offset the shock from this very real disadvantage is the enticing figure of well over 80 per cent thermal efficiency, coal pile to switchboard, which may be obtained by this technique.

Very seriously, however, the writer is inclined to regard this technique with a favorable eye. The difference between Today and Yesterday is that a temperature of 15,000 F can be obtained now. The difference between Today and Tomorrow will be that 15,000 F can be harnessed. Described above is one idea that will put it to use.

A fourth technique investigated for minimizing conducted heat loss from a thermoelectric generator is to employ the lowly Thomson effect (Ref. 1). The Thomson effect is a thermoelectric phenomena of the conductor itself in which a voltage is induced proportional to the temperature gradient along the conductor, the current flowing and the Thomson coefficient. It is ordinarily an insignificant effect even with great temperature differences, inasmuch as the Thomson coefficient is so small. However, if one can imagine a hot junction connected to a cold junction by myriad small conductors, the combined area of which is equal to that of the original single conductor but the individual area of each being such that only the amount of heat can flow by conduction that is exactly balanced by the Thomson heat, from which is generated electrical energy, a generator is there which will convert conducted heat into electrical energy at Carnot cycle efficiency.

The stumbling block here lies in the world "myriad." It must be thought of in its largest sense, that is, the individual conductors must be tremendously small. The requirements of voltage per thermocouple for the success of this method are also somewhat beyond the realm of possibility at present. In this connection, however, it is well to note that existing information on the Thomson effect coefficients for refractory materials is very skimpy and unsatisfactory. More knowledge is required here before any definite statement can be made that this method is not feasible.

The design of a practical thermoelectric generator having good efficiency is thus beset with many difficulties. The greatest need, as we have seen from the foregoing discussion, is for research on the problems indicated. Such research should include, too, the actual building and operation of thermocouple generators for high temperature service.

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THE GROUNDED NEUTRAL IN HOLLAND

By H. WIELAND LOS
Zaandam, Holland

IN 1909 WHEN THE writer first became familiar with the electric light and power industry in Holland, the development of internal combustion engines and electrical machinery was still in its infancy. Power was generally produced by illuminating gas engines, up to 20 hp from 20 to 1200 by oil, producer gas and steam engines. Central Stations were an exception; public buildings, shops and amusement centers produced their own light and power. These years represented the period of arc lamps, direct current generators and storage batteries.

The battle between gas and oil engines was not yet decided. In the meantime a third type of plant, the locomobile steam power plant, pushed to the front by German manufacturers, fell a victim to the trend of the times—the average plant owner preferred some degree of semi-automatic operation and a minimum of obligations to the burdens of housing, operating and inspecting fired pressure vessels. As a consequence, the import of gas and oil engines increased considerably and gave rise to the development of a national power industry.

Gradually many internal combustion engines were replaced by electric motors. The energy was initially supplied by small privately owned electric companies. Later on, the municipally owned station succeeded the products of free enterprise and started to build their transmission lines far into the suburban districts. So high-tension alternating current systems came into use and many central stations were turned into mixed plants, inasmuch as the majority of them were originally designed for the sole production of direct current.

In 1915, twenty-seven stations generating direct current were registered, 10 housed d-c and a-c machinery, and 35 represented the a-c group, of which 15 covered pronounced suburban territory. These ratios were reflected in the primary and secondary transmission line voltages varying from 3000 to 10,500 and 72 to 380 respectively.

Lighting voltages of 72, 110, 120, 130 and 150 were becoming obsolete and means were required to keep the load symmetrical in all parts of the system. These requisites were embodied in the adoption of the 200/380 standard voltage involving a four wire, three-phase, grounded neutral system. Small motors, domestic appliances and lamps were supplied by connections between either of the three phases and the neutral, the resulting voltage being equal to $380 \div \sqrt{3} = 220$.

The change was brought about gradually by the existing corporations and consolidated during the expansion of the municipal stations and rise of the provincial undertakings.

The presence of the grounded neutral has resulted in many complaints and quite a number of fatal accidents due to the human body acting as a conductor between a phase wire and the earth, that is, the grounded neutral.

Only recently, an electrician, handling a portable electric drill in a dairy plant, where everything is wet, was instantly killed when drilling holes in iron sheets, very likely due to the presence of the notorious neutral.

Of course, measures have been

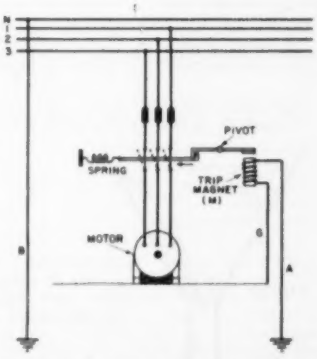


Diagram of automatic switch protecting motor circuit using grounded neutral

taken to guard against accidents. Grounding the metal parts of an electrical machine or device is a common procedure, but it is quite a problem to maintain a perfect ground connection. A practical test can be made by means of a 25 amp fuse screwed into a block. One side of it is connected to a phase wire of the feeder, the other to the (loosened) ground wire. If the fuse blows, the grounding of the machine has passed inspection.

Often the neutral is not fused, in order to prevent interchanging the wires leading to switches and lamp sockets which is said to happen when both the phase and neutral are fused.

Some provincial distributing agencies prescribe the installation of a special circuit breaker. In initial contact between conductors and the metal frame of a machine results in sufficient current to make the breaker open the circuit, even when the ground contact resistance is abnormally high.

The breaker is wired as in the accompanying sketch. The switch is opened when the frame of the motor MR is grounded and current flows through the ground connection G, the magnet M, via the auxiliary ground pipe A and the main one B. The latter is connected up to the neutral N in order to complete the circuit.

When the magnet is excited it will trip the breaker by means of a spring and lever arrangement, even if the current is as light as 25 milli-amperes.

A Shorter Funnel Solved this Filter Paper Problem

By A. THOMPSON

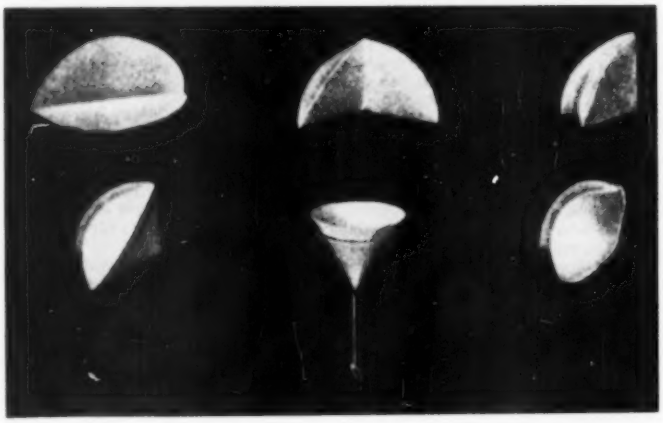
WHEN ATTEMPTING to use our boiler water test kit, we were puzzled to find that, although we used the filter paper and funnel supplied by the manufacturer (a leader in the field), the suspended matter was rarely removed from the samples.

Thinking that possibly as we poured the water into the funnel a little was spilled outside the paper, we tried using a medicine dropper, being sure that not a particle of water went astray, but the results were the same.

Careful examination of the filter paper never disclosed a hole, but in case there might be any defect in the paper a new lot was obtained from the manufacturer; however the results were no better.

At last we theorized, strange though it seemed, that capillarity within the fold of the paper provided a duct by which water was siphoned to the bottom of the funnel (Fig. 1). Accordingly, the plastic funnel was cut off as shown in Fig. 2. Thereafter the filtrate invariably came down crystal clear, showing that our assumption had been correct.

Editor's Note:—It seems strange that this interesting problem of capillary action in filter paper hasn't come up before. Four years ago, the October, 1945, issue of Power Plant Engineering carried the photograph reproduced above, showing the correct way to fold a filter paper. Notice that the top edge of the funnel is considerably lower than that of the filter paper. Both the illustration and the directions accompanying it were part of an article on water testing by E. O. Davis.



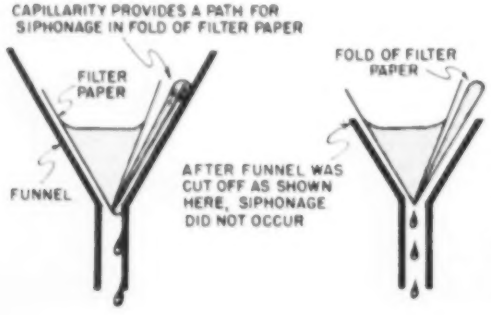

CAPILLARITY PROVIDES A PATH FOR SIPHONAGE IN FOLD OF FILTER PAPER
FILTER PAPER
FUNNEL
AFTER FUNNEL WAS CUT OFF AS SHOWN HERE, SIPHONAGE DID NOT OCCUR
FOLD OF FILTER PAPER

Fig. 1. (Left) shows how siphonage induced by the too-high funnel made the filtering process practically useless. This was remedied (Fig. 2) by trimming down the plastic funnel

How to Fold a Filter Paper

1. Fold a single paper in half, crease it to hold, but not enough to break the paper.
2. Fold it in quarters.
3. Now separate it so that you have three paper thicknesses on one side and one thickness on the other. It is now in the shape of a closed cone. You can see that if you pour a liquid into this cone, it must filter through.
4. Insert the cone point down in the funnel and filter your sample slowly through it.

The most efficient engine in the world is the diesel, which delivers as high as 36 per cent of the power potential in its fuel, as against 30 per cent for the steam turbine, 24 per cent for the gas turbine and 8 per cent for the steam locomotive.

WATER TREATMENT

How New Water Test Determines Calcium and Magnesium Hardness Separately

By A. O. WALKER, Ph. D.
and
R. S. ROBERTSON
National Aluminate Corp.

Here's how the authors have modified the new total hardness test for water so it will give the complete hardness picture more accurately than any previous method . . . New procedure gives calcium and magnesium hardness separately, as well as total hardness . . . New total hardness test, described in December issue, gives result adequate for many purposes . . . However, authors show why it is necesary to know both calcium and magnesium hardness in lime-soda softening; in internal treatment of boiler water; in preventing pipe line and equipment corrosion; in recirculating cooling water; in many other types of water problems . . . Here are complete directions for carrying out the new test to determine both calcium and magnesium hardness in ppm expressed as Ca CO_3 . . . Technique of the tests, precautions to take and accuracy of results discussed . . . As before, the test employs colorimetric titration of the sample, uses simple equipment, can be made on the job

FOR SOME YEARS, quantitative methods have been under development for employing a tetraacetate compound to determine the concentration of calcium and magnesium and certain other metals in solution. These methods were based on the behavior of ethylenediamine tetraacetic acid toward calcium and magnesium, which was known as early as 1945. Recently, after undergoing many revisions, such a method, employing the tetraacetate, has been adopted for accurately determining the total hardness of waters. This is sometimes called the versenate method. It was aptly described by F. R. McCrumb in the December, 1949 issue of POWER GENERATION.[1]

The method there described is simple, rapid and accurate; and it probably will replace other tests for total hardness. However, its one serious limitation is that it fails to differentiate between the calcium and magnesium that make up the total hardness.

When Total Hardness Content Is Used

The total hardness content is of value. It gives the consumption of soap or similar agents by the hardness of the water. It can be used in checking the effluent of ion-exchangers where effluent is not to be used as high pressure boiler make-up. It is valuable to municipalities that partially soften their city supplies. Where the calcium and magnesium content are known to exist in the water at constant ratio, the total hardness would give all the information necessary. However, once the water has been treated in any way, that ratio will no longer be the same.

In nearly all other cases the calcium and magnesium content must be separately known in order to apply chemical treatment effectively. While the two elements are similar in some ways, they are for the most part, dissimilar in their reactions. For proper conditioning of water for most industrial purposes, their individual concentrations must be taken into account.

When Separate Calcium and Magnesium Values Are Needed

In lime-soda softening calcium is precipitated as calcium carbonate and the magnesium as magnesium hydroxide by the addition of sodium carbonate and calcium hydroxide. If the amounts of calcium and magnesium individually are unknown—i.e., if only the total hardness is known—one cannot expect to adjust the chemical proportioning to obtain proper softening. Also, in the softener effluent, unless the calcium and magnesium are known individually, one cannot make corrections to improve the softening without expensive guesswork.

Where a plant draws its water from a river, the ratio of calcium hardness to magnesium hardness in the water may vary widely, depending on the amount and origin of rainfall. In extreme cases, this ratio may change radically in the course of a few hours.

To determine the exact amount of lime and soda ash needed to precipitate both calcium and magnesium, both contents must be determinable. Failure to adjust chemical dosages properly will result in incomplete softening and possible damage to boilers and other equipment.

In internal treatment of boiler water, the physical characteristics of the sludge must be controlled to prevent its adherence to heat transfer surfaces. Control of these characteristics can be brought about only by the strictest attention to the calcium and magnesium content of the feedwater. Knowledge of the total hardness value alone is not sufficient.

Calcium, when precipitated as calcium phosphate in the boiler, yields a sludge that, when properly conditioned, will not adhere to the heat transfer surfaces. However, magnesium phosphate renders a sludge sticky and adherent. It is preferable to precipitate magnesium as magnesium hydroxide, which is more readily conditioned. Therefore, accurate knowledge of the calcium and magnesium content of the feedwater is necessary for proper proportioning of the phosphate and alkaline treating chemicals.

In waters containing large amounts of silica, care must be taken to avoid the deposition of calcium silicate. Calcium silicate scale is often removed only by tedious mechanical means. Magnesium silicate in the sludge is readily made non-adherent. Calcium silicate formation is prevented by precipitation of the calcium as calcium phosphate. Knowledge of the calcium and magnesium content of the makeup water is essential for proper control of the phosphate treatment.

The calcium content of water plays the major role in corrosion and incrustation of pipe lines and equipment. Calcium carbonate under controlled conditions can be maintained in a protective film covering the metal surfaces and aiding in the prevention of corrosive attacks. With-

[1]New Versenate Test for Total Water Hardness Eliminates False End Points; by F. R. McCrumb; POWER GENERATION, December, 1949

out control, the calcium carbonate film will grow beyond tolerable limits, interfering with flow rates and heat transfer; or it will disappear, inviting corrosion. Magnesium compounds are seldom incrusting and they play little part in the prevention of corrosion. Thus it is necessary to know the calcium and magnesium contents separately. For further information see the literature[2] concerning stability index.

In recirculating cooling waters, where high concentrations often occur, harmful calcium sulfate can be deposited in the system. It is important to know when the calcium content is reaching a danger level through concentration, so that adequate blowdown can be maintained. Magnesium sulfate does not offer the problem, so the total hardness value alone is of little use.

It may be appreciated, therefore, that the differentiation of calcium and magnesium in water becomes an indispensable tool of the water treatment engineer.

How the Total Hardness Test May Be Modified

The authors found that with certain modifications of the method described by McCrumb, this differentiation can be obtained.

Since calcium oxalate is very insoluble, it was found that the calcium could be precipitated as the oxalate and filtered off before titrating to obtain the magnesium hardness separately. However, such a process, if done according to accepted techniques, would be too time-consuming to be practical.

It was found that, under certain easily-controlled conditions, the calcium could be precipitated as the oxalate and the magnesium titrated directly without filtration. The calcium then could be obtained from the difference between the total hardness and the magnesium hardness.

Thus, employing the colorimetric titration for total hardness and the proposed method of the authors for magnesium, the complete hardness picture can be obtained more rapidly and accurately than by any previous method. Here is the way to conduct the test[3] to obtain this result.

PROCEDURE:

Total Hardness:

1. Take 50 ml of clear water to be tested. Add to a 250-ml flask.
2. Add 1 ml of buffer solution and mix. Add 4 drops of indicator, and titrate with standardized tetraacetate solution until the red color is just discharged. The endpoint is indicated by the discharge of all the reddish coloration, regardless of the final color of the indicator.
3. The number of ml of tetraacetate used multiplied by 20 equals the parts per million of total hardness as calcium carbonate.

Magnesium Hardness:

1. Take 50 ml of the clear water to be tested and add to a 250-ml flask. Water should be at room temperature (20 to 25 C, which is equivalent to 68 to 77 F).
2. Add 1 ml of buffer solution, 5 ml of oxalate solution and allow to stand with occasional mixing for 5 min. The buffer used in this step was specifically developed for this particular method.[4]
3. Add 5 drops of indicator and titrate rapidly with tetraacetate solution, agitating thoroughly throughout the titration. Take the first disappearance of red color as the endpoint.
4. Subtract 0.1 ml from burette reading, and multiply this corrected reading by 20 to give the parts per million of magnesium expressed as calcium carbonate.

Calcium Hardness:

The calcium is obtained by subtracting the magnesium hardness from the total hardness.

In titrating for the magnesium, titration over 10 ml must be avoided. The titration must be done rapidly, taking the first complete discharge of the red coloration as the endpoint. On standing the red color will return. However, sufficient time is available to make an accurate titration of the magnesium before the calcium can react. Care must be taken not to over-titrate. For this reason, the last small portion of tetraacetate should be added dropwise with vigorous agitation.

The method gives results reproducible to within 0.1 ml of titrating solution and in close agreement with gravimetric results. Concentrations of ions normally present in waters do not interfere.

[2] "A New Index for Determining Amount of Calcium Carbonate Scale Formed by a Water;" by John W. Ryznar, *Journal American Water Works Association*, April, 1944

[3] Editor's Note:—Equipment required for the tests is exactly the same as that described by McCrumb, December issue, see Footnote 1. For additional information on the standardized titrating solutions, color indicators, buffer solutions—their composition, how to prepare them or where to obtain them from chemical suppliers—also more technical data on interferences, testing techniques and other details, write the editors.

[4] The buffer adjusts the pH, as usual, but also prevents the precipitation of magnesium

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"DRY-ICE" FROM BOILERS

BY-PRODUCT STEAM and by-product power are common in the terminology of process industries, depending upon whether power or steam is the primary objective of generation. But it is unusual to find steam a by-product of the process itself. This, however, is the case in the manufacture of "dry-ice" from CO_2 in the flue gases by the Girbotol Process, as conducted at the Chicago plant of Pure Carbonic, Inc., one of the largest suppliers of "dry-ice" with a daily capacity in excess of 140 tons.

With this process it is desirable to carry the CO_2 in the flue gases as high as possible to permit maximum extraction, even with some sacrifice in boiler efficiency, inasmuch as the steam is a by-product used to drive auxiliary equipment and for plant heating.

The boiler installation, put in last spring, consists of one 30,000-lb per hr and two 15,000-lb per hr Combustion Engineering Type VU steam generators burning coke breeze on Coxe traveling grate stokers with oil as a standby fuel.

It was recently decided to conduct a test to determine equipment capacity with a view to increasing the daily output. Accordingly, the test was carried on for a period of two weeks with the largest boiler operating at a load 20 per cent in excess of its maximum continuous rating, during which time the CO_2 ranged from 17 to 18 per cent with a corresponding efficiency of 65 per cent. When it is considered that this efficiency concerns the by-product steam output alone and that the primary product is maximum carbon dioxide, with extraction up to 90 per cent, the exceptional performance of the steam generating unit may be more readily understood.

Visual inspection of the boiler, when taken off the line at the conclusion of the test, indicated less slagging than is experienced under usual operation and no adverse effects upon the refractory parts of the setting.

INTERNATIONAL AUTHORITY ON LIGHTNING AWARDED THE 1949 EDISON MEDAL

Dr. Karl B. McEachron, of Pittsfield, Mass., has been awarded the 1949 Edison Medal, it was announced here today (Monday, Dec. 19).

The Medal, given annually since 1909 to outstanding electrical engineers and scientists, will be presented to Dr. McEachron, Manager of Engineering, Transformer and Allied Product Divisions of the General Electric Company at Pittsfield, at the Winter Meeting of the American Institute of Electrical Engineers in New York at the Hotel Statler, Jan. 30-Feb. 3.

According to J. B. MacNeill, chairman of the Edison Medal Committee of A.I.E.E., the honor was conferred on Dr. McEachron for "His contribution to the advancement of electrical science in the field of lightning and other high voltage phenomena and for the application of this knowledge to the design and protection of electric apparatus and systems."

PRACTICAL HINTS AND KINKS

ANTI-PLUG CIRCUIT ELIMINATES COMMUTATOR MAINTENANCE

Simple timing device prevents careless personnel from damaging motors through improper operating procedure

By DEAN HUIDSTON

I AM ENCLOSING A sketch of an anti-plug circuit which I have used with much success in the past year.

With this circuit I have eliminated commutator troubles on locomotives, larries and various coke oven machines where unskilled operators plug motors and advance drum controllers too fast.

The extra contacts needed in the drum controls were added where an old type control was used or where more modern controls equipped for shunt motor operation were used and no work was required on the drum controller.

The operating sequence is as follows:

1. Timer coil is energized with drum control in off position.

2. Drum control is moved to first position, forward or reverse as can be seen in the diagram, the contactor coil is not energized until timer contacts close.

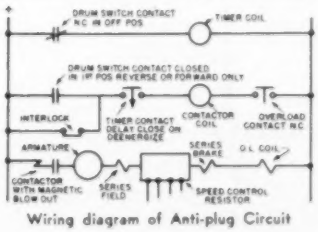
3. Through all other drum control positions interlock contact holds contactor in, except in case of overload. When overload trips out, it is necessary to return to first position to start motor again.

Previous to installation of this system it was common practice for operators to swing the drum control handle from full speed forward to full speed reverse. Now, it is necessary for the operator to pause in the first position, thus the machine is rolling before full power is applied.

The timer used is of the pneumatic type while overload relays are instant trip magnetic set to trip at 200 per cent load current.

I might add that the motors are located in places where the temperature is too high for thermal relays or standard commercial plug switches to operate; also the machines are too heavy to bring to a quick stop with the series brakes used.

The combination of anti-plug and instant trip is the only way to eliminate commutator flash-over troubles on drives operated by unskilled personnel.



Wiring diagram of Anti-plug Circuit

PRACTICAL SIGNAL SYSTEM, EASY TO INSTALL AND MAINTAIN

By MYRON C. ZIEMKE

IT IS APPARENT from the many types of *hoist signal systems* one encounters about the country that the designers certainly had free reign to carry out their pet theories, and their heirs in many cases suffered accordingly. One circuit viewed had "grown up" like Topsy from a meager little 10 v dry cell circuit to a mature 115 v d-c system by dint of cutting a carbon lamp in series with the old vibrating bell on the hoist house wall.

The reader can imagine what a sweet time the electrician had in keeping the contact points on that old bell in operating shape and the old "grapevine" still worked only in the one direction, a deplorable condition indeed where no phone system is in use.

Illustrated is a circuit that is simplicity itself in that only six leads are required to provide two-way service on two skip ways and the man hoist. Note also that legs "A" and "B' extend the length of the shaft and may be tapped for light 115 v a-c service such as auxiliary systems, public address systems (yes, modern mines have them) emergency lighting, power to telephone rectifiers and a source of ready power to maintain dry atmosphere in cable vaults and pull boxes by the use of carbon lamps. No. 12 gage R C wire in sealed conduit will serve for most installations but for the large projects submarine type cable with a spare conductor for later emergencies is recommended for extreme exposure to moisture and uninterrupted service.

All stations in the man-way have return bells that indicate the engineer has clearly understood the code signal. A green light indicates the signal as the sender signals the engineer and operates as a check on the effectiveness of the circuit. Bells were omitted from the skip ways lest they confuse the signals on the man-way side of the shaft, although different toned bells might readily be employed if desired. For the code sending check by sender and engineer a green light in each

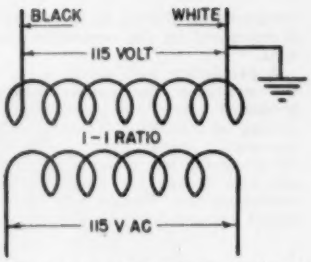
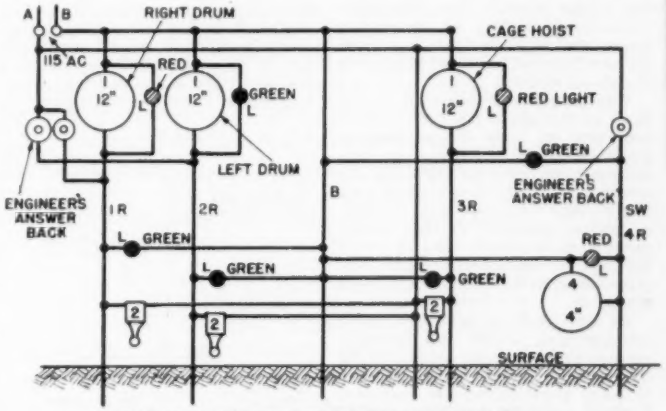


Fig. 1. 1 to 1 ratio insulating transformer



DUPLICATE EQUIPMENT UNDERGROUND AT EACH STATION.
6 - 10 LB B AND S RG CONDUCTORS IN SUBMARINE CABLE

1 - 12" TWO GONG VIBRATING BELLS 2 - PULL SWITCHES
3 - 4" TWO GONG VIBRATING BELLS 4 - 20 WATT ROUND BULBS. 4 - 4" DOUBLE GONG

Fig. 3. Wiring diagram of Signal System

compartment flashes as the button is depressed by the respective persons.

A precaution well worth using is the provision for supplying ungrounded 115 v a-c power by inserting an insulating transformer in the supply leads. This cancels out the grounded leg of the power supply and makes for long uninterrupted service. Should a leg of the signal service become accidentally

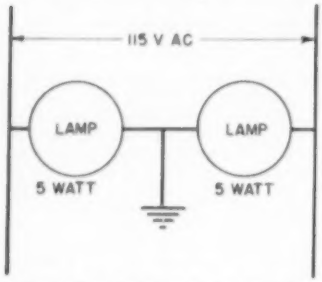


Fig. 2. Use of lamps as ground detector

grounded the defect will cause no immediate trouble, until a second ground on the other leg occurs.

To check on this happening the simple two lamp detector is installed at the service entrance to indicate the gradual infiltration of moisture as one lamp dims and the corresponding lamp brightens. A contact direct to ground darkens one lamp, while the other is at full operating brilliancy.

CARE AND OPERATION OF OUTSIDE FUEL OIL TANKS

By W. F. LORGE

Plant Operations Superintendent
Minnesota School for Feeble Minded

Due to natural gas shortage in the winter months from November until April or May at our power plant, we are compelled to operate on one-hundred per cent oil during the above months.

When the writer took over operations at this plant, the fuel oil system was in poor shape, because previous to this, fuel oil was very seldom used only as stand-by for emergency cases. Then, about four years ago natural gas became a scarce product during winter months, so the writer had to revise the fuel oil storage and entire distribution system to meet the present condition.

At our plant we have two inside underground, 15,000 gal capacity storage tanks and one outside 54,000 gal capacity storage tank. Due to inability to get delivery on fuel oil it became necessary for the writer to fix this outside fuel oil storage tank so that we could store greater surplus and still get it back into the inside tanks when needed by pumping it into the inside tanks. When one realizes that at our plant in extremely cold weather we use from 7,500 to 9,000 gal. of No. 5 fuel oil per twenty-four hours, our storage capacity is still very small, total being about seven or eight days. So the writer realized that all available storage space had to be used. Some amount of investigating was done to determine exactly the type of equipment to install in this outside storage tank that would do the job and still be economical, so the writer is enclosing a sketch of what was done to enable us to make use of the outside storage tank capacity and do it as efficiently as possible. This system has been tried out and tested and has proven to be an excellent job.

When one realizes what this No. 5 Street and Bunker Oil gets like in the winter at fifteen or twenty below zero our results are quite remarkable. So regardless of temperature in the winter months we are able to give and take as desired from our outside storage tank and do it as economically as possible. Also the writer wishes to add that it is very advisable to use a good fuel oil sludge dispersing treatment wherever storage tanks are involved. A treatment of this type will not only tend to keep down sludge accumulation, but will aid greatly in screen and burner operations.

To begin with, our outside fuel oil storage tank is about 300 ft from our power plant. The writer had a 3 by 5 ft tunnel dug into the plant, thereby enclosing all service lines that would be needed to the storage tank, such as fuel oil pump line, steam line and electric power line. Adequate lighting was also installed in this tunnel. A hole was cut into the storage tank and into this was welded a flanged neck to accomodate the envelope of the heater. On the end of the envelope was placed an 8 in. gate valve with universal joint and shaft leading to top of tank that could be shut off, even if tank was full of oil, and coil slipped out and repaired. The steam coil the writer had made up by a reliable concern, is capable of melting down 1500 gal per hr at 20 deg below zero, delivery at 100 deg temperature. Our pump pumps in 900 gal per hr into our inside tanks where other pumps pick it up from there to the final heaters and to the burners.

The heating element as will be noted, is constructed of ¾ in. diameter thin wall steel tubing hairpin return bend shaped. The heating element has a total of 45 sq ft heating surface and constructed to operate on 40 lb minimum steam pressure.

As will be noted, the oil enters the envelope through the 8 in. gate valve and passes through the baffled envelope inside housing coming in contact with heating element. The inside pump suction line is hooked up to the 2½ in. oil outlet at outer bottom end of envelope. Heating element is of divided head construction, upper half steam, lower half condensate return. The steam control valve is a Minneapolis-Honeywell motorized position indicating valve operated from remote control panel in power plant oil stand-by equipment room with pilot light. Also on the steam trap is a clamp on temperature Minneapolis-Honeywell surface aquastat that is set at 80 deg so if the trap ever fails, this temperature aquastat will make contact due to cooling down of steam trap and onto this aquastat conduit and wires are run through the tunnel to power plant oil equipment room where an alarm bell is hooked into the circuit with a low voltage Minneapolis-Honeywell bell transformer operating on 12 v a-c and a switch on the bell circuit.

The bell alarm circuit is switched on only when we are actually pulling in oil. The operating technique used at our plant is when we need oil in our inside tanks, the engineer on shift, switches on his automatic control for the heater for about five minutes before starting pump. The heater in this outside tank immediately starts melting down oil at the rate of 1500 gal per hr, then after

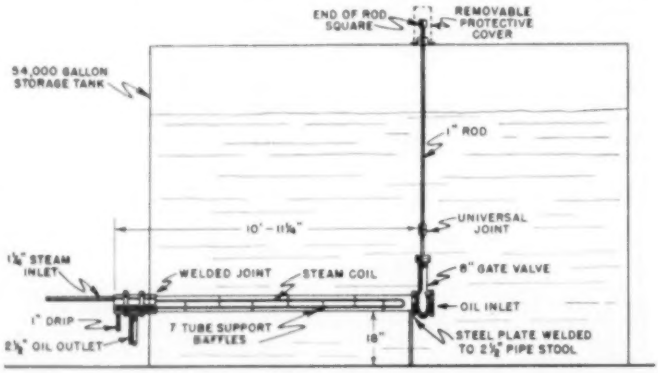
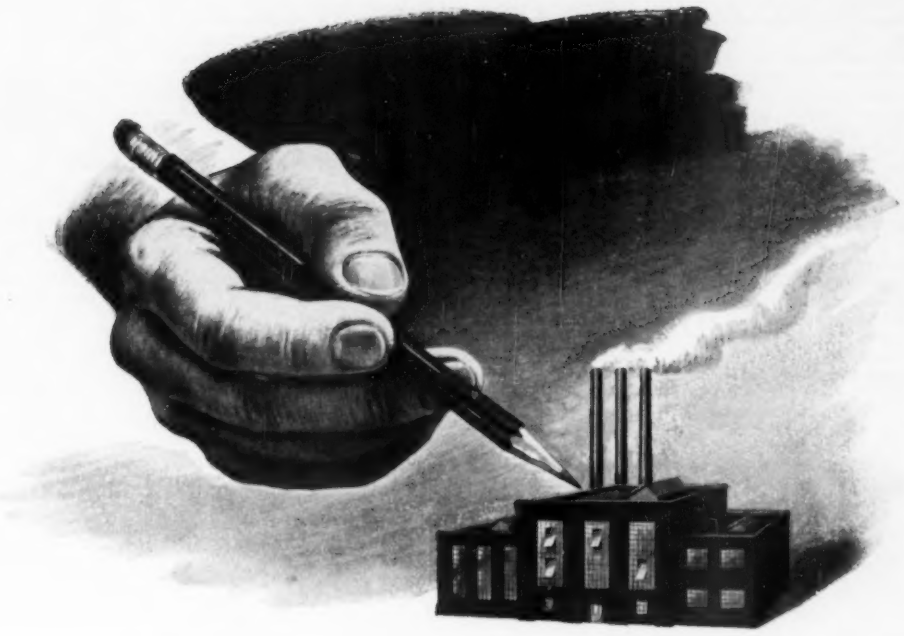


Diagram showing details of heater in fuel oil storage tank



Let's Talk About *Your* Boiler Plant

In particular, let's talk about water conditioning in your boiler plant.

First, we should recognize that complete and efficient water conditioning starts with the raw water and continues through the plant, taking in many problems. "Trouble-spots" may occur at many points throughout the system—from the raw water intake to the boiler blowdown discharge.

Secondly, *correct* water conditioning is a matter of careful and scientific control. For proper results you should be sure to choose a water conditioning service offering the very best in up to date engineering practice.

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about five minutes the pump is started and the oil is pulled in at the rate of 900 gal per hr, one-hundred degree delivery. After pump is started the engineer also throws on the steam trap alarm circuit. Trap has heated sufficiently by this time to open points on temperature aquastat and hold bell out of circuit unless trap is clogged up or other faults. Bell stays out of circuit as long as trap operates correctly. When we have pulled in sufficient oil, the above operations are reversed simply by the engineer operating small pilot toggle switches from the main oil equipment room.

With this type of automatic hook-up arrangement, we only have to be applying steam to our outside tank as we desire to draw oil out for our inside tanks. Without this type of an arrangement, we would either have to have steam on this outside heater steady twenty-four hours a day all winter or do a lot of running back and forth and operate by hand, which would be pretty near impossible without additional manpower in the winter due to distance. Also the engineer and fireman are very well occupied when on one-hundred per cent oil with four boilers to watch plus the power plant, etc.

Our power plant turns out over a million pounds of steam during winter months, per 24 hr, besides large generating load, etc., so the writer drew up the plans for the above described automatic control and alarm system and pumping arrangement. We consider it to be ideal for our needs and very efficient as steam is only used while actual operations are going on.

The condensate from this heater is naturally wasted as the writer felt it would be taking too much chance to try to reclaim it, without installing elaborate equipment for just this one trap unit. Perhaps some day we will attempt to reclaim the condensate.

FAULTY BOILER HOOK-UPS

By ALBERT H. MOULTON

IN TRAVELLING AROUND and seeing many different types of power plants, one often sees faulty boiler connections and mis-applied boiler accessories. One freak hook-up that is sometimes used and seems to pass inspection and meet the approval of engineers is the gravity return of condensation from steam headers to boilers, along with automatic non-return valves on steam outlets of boilers as shown in sketch. Now, gravity returns from headers are OK and so are combination stop and non-return valves, each serve a good purpose, but the two should never be used together.

The gravity return where there is enough drop between bottom of header and water level in boiler is a simple and reliable means of returning hot condensate from header directly to boiler without the use of steam traps, steam loops or high pressure receivers and condensate pumps. It consists of merely a drip line running from bottom of header into boiler where it is discharged below water level and having a shut off valve at header and at boiler with a check valve located between the two and near as possible to boiler, so placed as to let water flow into but not out of boiler. The non-return valve is good protection for the boiler, when properly installed and kept in good order, but, of course, requires care like everything else and should be inspected and overhauled at least once a year. But like lots of other apparatus in boiler rooms it doesn't get that close attention as a rule. As already stated, each of these is fine in itself; but they should not be used together for the simple reason that the return line makes a by-pass around the boiler non-return valve when it is open which usually is when boiler is on line. If the non-return valve is called upon to act when that boiler stops steaming or more especially when there is an accident to boiler, it will close, shutting off back flow of steam from header branch pipe. But unless the return to that boiler is also shut off there will be a 1¼ or 1½ or perhaps a 2 in. by-pass connecting boiler with header tending to hold pressure in boiler which might be serious in case it becomes necessary to get pressure off boiler quickly, for in the press of an emergency the return might not get closed.

Now the point is, if the protection of a non-return valve is needed as it usually is when boilers are connected to a common header, it should not be by-passed and the header should be drained either by steam traps discharging returns to an open heater or by high pressure receiver and return pumps. The steam loop is not practical as a heat saver and is expensive to install and keep up.

THE HOOK-ON AMMETER

Some of the results that can be obtained with this instrument . . . Portable . . . Easy to read . . . Applications almost unlimited

By GEORGE A. AIKEN

TO THE OPERATING or plant engineer who also has charge of the electrical department of the power plant and mill or factory, there is an electrical testing meter that should prove invaluable. He will find a great many uses for it about the power plant and the mill.

This handy, versatile electrical instrument is none other than the hook-on type ammeter, which is made by a number of reliable electrical instrument concerns.

This type of ammeter is very convenient for use on a-c circuits since it can be used without breaking into a circuit, handling wires or leads, or causing even a momentary shutdown of motors or any other electrical equipment.

The hook-on ammeter is a split-core current transformer with its secondary winding tapped for the different ratings and connected through a rectifier to a meter through a range-changing selector switch.

To read the current or amperes, just press the hook-button or trigger and the jaws open, then encircle it about each wire individually. You can then obtain the reading of the current passing through each wire; this can be done on single, two and three phase circuits or wires. Check the reading taken on the ammeter by the nameplate data on the motor, transformer, breaker, etc. in amperes. The a-c ranges are from 0 to 2000 amp and can be used on frequencies between 50 and 70 cycles and has an accuracy within 3 per cent.

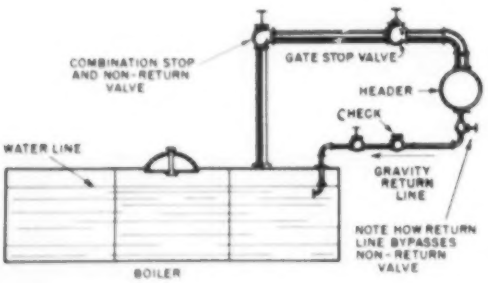

Fig. 1. Combination Stop and Check and Gravity Return connected to the same boiler

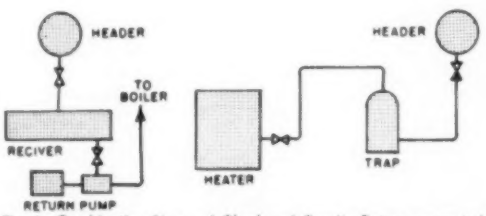

Fig. 2. Return systems which can be used when the boiler has a non-return valve

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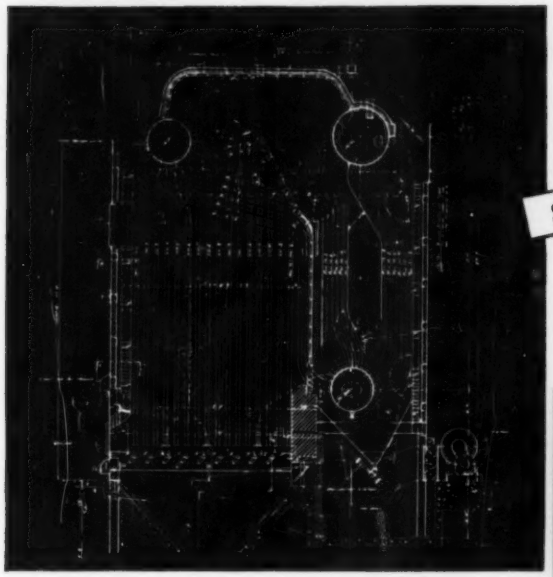

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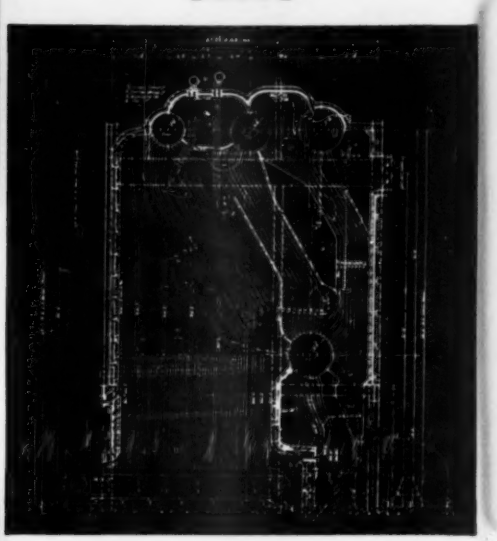
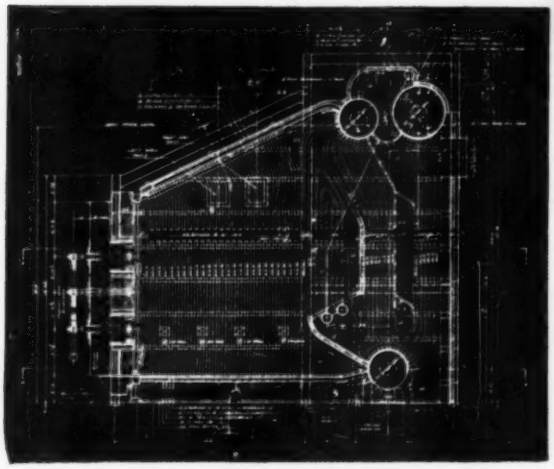


CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

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These instruments usually have 6 ranges to select from; can be carried around by hand; in a leather case over the shoulder or on a strap attached to your belt. They are good on voltages up to 600 v. It is not necessary to wear rubber gloves as the Bakelite handle is of non-metallic construction. The jaws can open up wide enough to take an electric cable or bus up to 2 in. in diameter.

Are your electric power and light bills too high? Why not make a rough survey of your entire mill? This can be done quickly and easily with a hook-on ammeter.

Are some of your motors, underloaded, or just loaded to the nameplate capacity?

It is a well-known fact that underloaded induction motors operate at a very poor power factor and draw an excessive amount of lagging current. This causes undue heating and power loss in all feeder lines and in the distributing system clear back to the switchboard in the powerhouse.

Frequently these difficulties can be overcome or helped by checking the loads, and, on the basis of such checks, you can swap or interchange one motor for another somewhere else in your mill that is nearer the size that can carry the load properly and thus improve the power factor. For example, swapping an overloaded 3 hp motor for an underloaded 5 hp motor; then they will both be carrying a more efficient and economical load.

If the hook-on ammeter is used on single phase 110-220-v equipment, the ammeter will not operate if encircled around an asbestos or rubber covered conductor having two wires in it. To use the hook-on ammeter in this case separate the wires temporarily. Sometimes the two wires are split apart enough at the connection in the motor junction box to be able to get the hook around them individually to get a reading.

Here is a list of some of the many uses that a hook-on ammeter can be put to.

It can be used to determine the current required to start a motor and under load; to check current required on a motor running without belt; running with belt on a friction load; and running with load all on. It will tell you when a motor is overloaded by checking with nameplate amperes of motor. Motor may not be big enough to carry the load; a number of times I have had to make changes before I had a motor that was not overloaded. Remember, one burned out 25 hp motor rewind bill will pay for a hook-on ammeter.

If the motor is heating up or doesn't appear to be up to speed, it may be traced to a plugged up pump, strainer, pipe, or a closed valve, etc. If the overload relays keep kicking out; it may be due to overload on the machine; it may be due to the relays being too light for the motor and the load; checking with the hook-on ammeter will tell you quickly. If the lead wires to a motor are heating up, it may be that they are loose at the connections to the motor. The hook-on ammeter can be used to find out if a motor can be used to drive a machine that is to be speeded up and not overload the motor.

If two or more motors are used to drive identical machines, the ammeter will show if one machine has more friction load on it due to lack of oil or grease in bearings of the machine; if clutches are slipping or dragging; brakes are dragging; parts are binding due to misalignment, etc. If two motors are attached to the same machine or shafting, it will show if one is doing more work than the other.

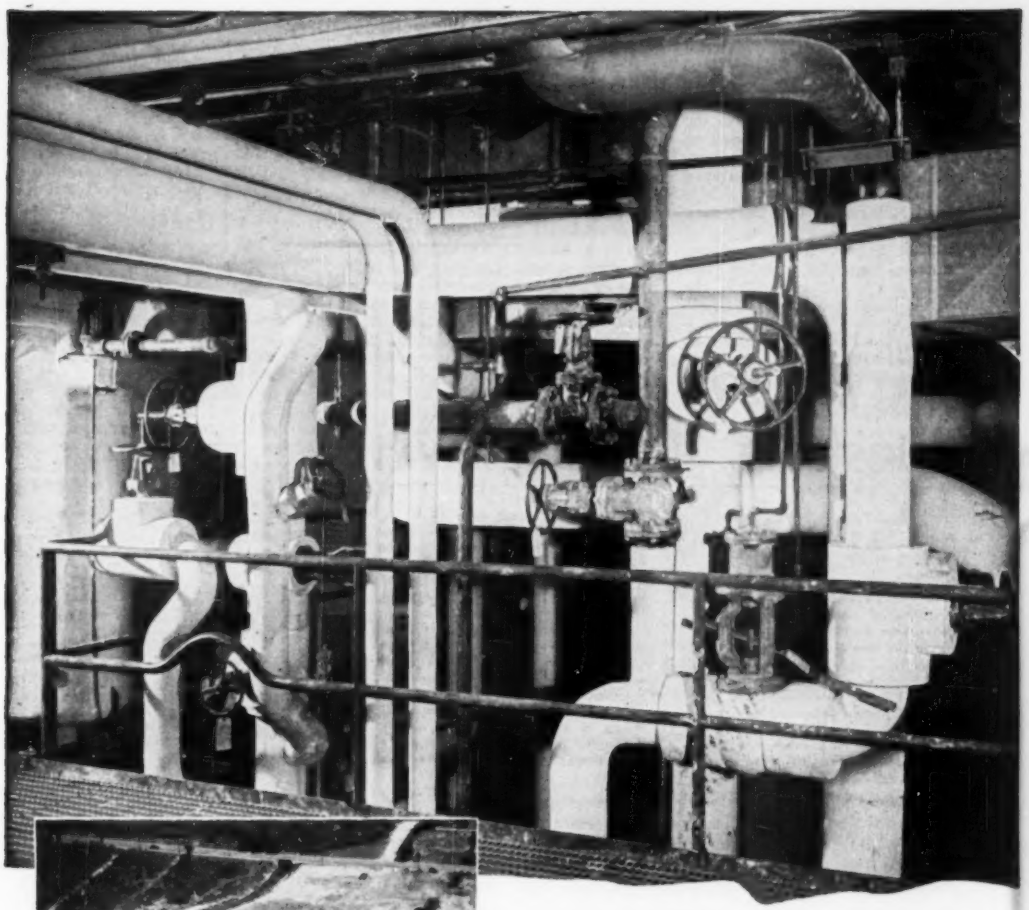
The hook-on meter can be used to check if a motor needs to be rewound; if the motor is running hot the load may be normal, the voltage is OK, it may be found that the bearings may heat or the rotor may have dropped and is rubbing. It can be used to determine whether any coils are shorted out in any phase or if any coils have been cut out in the past.

You may find that the heating up of a motor may be due to its running single phase. Clip the hook-on ammeter around each of the 3 wires, if 3 phase, and if one shows zero, then there is your answer. It may be a blown fuse, broken lead wire, faulty relays, etc. This may case some other motor on the same circuit to heat up or may possibly effect some motor throughout the mill due to back-voltage.

Sometimes a motor may be purchased second hand; if it is noticed that it runs real hot all the time, check the nameplate data, particularly the voltage stamped on it, for the voltage may have been restamped to correspond with the voltage in your plant; but the motor never was actually rewound to your plant voltage as it should have; this all can be found by readings taken by a hook-on ammeter.

In connection with your lighting system, relays, breakers and transformers, it will be found to be very useful.

For instance, your lighting transformer may be heating up; check the load with the hook-on to determine current. Then check it against the transformer nameplate data. It might be possible to swap some of the load



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over onto another transformer that is only partially loaded and balance the load up between them more evenly and efficiently. The fuses of the overloaded transformer may have been blowing often due to the overload. This also can happen to oil circuit breakers on your power panels, if they are not equipped with regular ammeters showing how they are loaded and why they may be tripping out so often.

You can, where there is room, hook around cartridge fuses on your board in fuse blocks or around the blades of old type knife blade switches.

Some of your lighting circuits may be overloaded and others only lightly loaded. Switching some of the load from the overloaded to the lightly loaded circuits will prove beneficial and stop fuse blowing.

I keep a loose-leaf book with the nameplate data of each motor. If a motor heats up, or if relays kick out or fuses blow, I hook the meter on quickly, take the readings, check it against readings taken in the past listed in the notebook. If you have it written down, then there is less chance for an argument.

It is so handy a meter, that after a while you will just naturally pick it up or send your electrical man for it when trouble arises. The department heads, if in doubt about some equipment in their department, will soon be asking that it be used to check the machines in question.

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOU HAVE a question about some detail of power plant operation, maintenance, design. You can't find the answer in your own experience nor in the books. So you write in to our editors. If we know the answer, we send it right back to you. (Maybe we don't know the answer either, but we usually know where to get it for you.)

In any case, we publish your question, signed only with your initials. We do not reveal your identity.

Dozens of engineers write in to us, giving their answers. We forward you copies of the replies as soon as we get them.

You, too, cooperate with other engineers by answering their published questions in the same way.

Then, so far as space permits, we publish those replies as soon as possible, so that everybody will learn what the others know about the problem. We pay well for all answers published. And those who answer get credit for knowing.

Simple, isn't it? And effective? Just ask the power engineer who has tried it!

Engineers who take the trouble to answer your question would appreciate some information from you, transmitted through the Q & A editor, on how their answers helped solve your problem. In doing this, indicate whether or not your comments could be published for the benefit of all readers.

Answer No. 450

WHAT CAUSES BURNER TROUBLE AND HIGH DRAFT IN THESE BOILERS?

IN OPERATING an arrangement of boilers as shown in the accompanying diagram, said C. C. S. in the November issue, they are having some trouble with Boilers 9 and 10. When dampers are closed so that the draft on these boilers is 0.08 in. to 0.09 in., as it should be at full load, they get a vibration and the burners back-fire and go out.

These boilers are fired from the side with natural gas, using register-type burners. They are equipped with Dutch ovens for burning bagasse. (See diagram page 92.)

The lowest they can reduce the draft on Boilers 9 and 10, says C. C. S., is 0.25 in. of water, whereas all the other boilers operate at 0.08 to 0.09 in. water. The CO_2 on Boilers 9 and 10 is very low.

Here are just a few of the many comments we have received.

Burners Not Mixing Fuel and Air Right, He Says

FROM THE DATA given, it can be deduced that sufficient oxygen is available for combustion at a draft lower than 0.25 if operation at that draft results in low CO_2. It is also obvious that sufficient furnace temperature is available if the burners operate with high excess air.

The difficulty appears to be in improper mixing of the gas (fuel) and air. The fact that a vibration results when the draft is reduced indicates an explosive or combustible mixture is available only in the space around the tubes (in the water tube boiler and comparable space in HRT) where insufficient temperature exists for combustion. The gas and air entering at the burners are not properly mixing in the combustion chamber and are passing through the furnace stratified or unmixed.

If mixing is required to produce proper operation, that fact can be proved by using steam or air jets to produce turbulence in the furnace. An available steam or air lance might prove satisfactory but care should be exercised in conducting the experiment.

It should be remembered that mixing as close to the burner as possible is most desirable. It is possible that the nozzles or apertures admitting gas to the burners are too small and are used with high gas pressures. If this is the case, high gas velocities result, forcing the gas farther into the furnace, then the air is drawn by the low draft. It also follows that if high draft results, in operation, the greater quantity of air will travel across the furnace farther and mix with the gas and result in a combustible mixture.

A curtain wall placed back of the burners, and extending quarter or half way across the furnace, might induce mixing. This could be constructed of low quality brick, laid up dry until the need was established.

Summarizing, C. C. S. will doubtless find the trouble at the burners, which are not properly mixing fuel and air.

South Branch, N. J. W. C.

Air Leakage and Poor Mixing, Says Brown

THE LOW CO_2 in these boilers indicates leakage of air into the boiler settings, where it does not aid combustion. The first thing to do is to give the setting a thorough inspection and stop all air leaks that do not aid combustion.

A lighted candle is all the equipment needed to find air leaks in a boiler setting. After all the air leaks are plugged, check the gas passes inside the boiler for slag, ash or other material that would prevent free passage of combustion gas through the boiler. When these passages are clean, check draft loss through boilers. It may be necessary to change the baffling so that there will be less interference with the travel of the gases of combustion.

The vibration and burners back firing and going out indicate a lack of air passing through the register of the burners.

Lombard, Ill. H. D. BROWN

Check Baffling, Burner Openings, Says Butcher

THE VIBRATION in the combustion chamber is the result of unstable conditions. Inasmuch as the other boilers operate at 0.08 to 0.09 in. water pressure and operate satisfactorily, I would suspect there is some internal difference in the baffling between say boiler 8 and boilers 9 and 10. This should be checked very carefully.

It would also be well to check the burner installation to see that the air and jet openings are properly adjusted.

If the burners are identical and the gas pressure is equal at boilers 8 and 10, the air and gas openings

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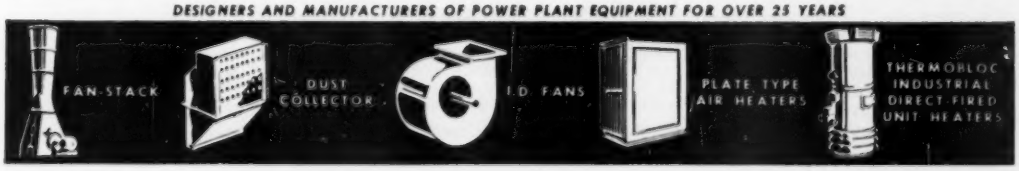
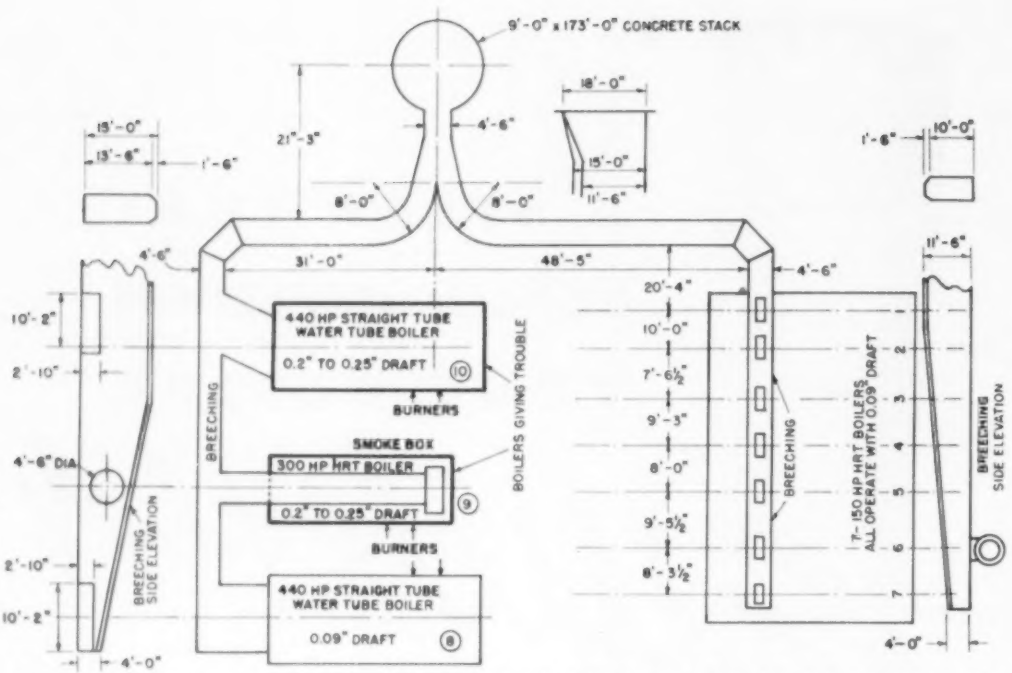




Plan of boiler and breeching arrangements by C.C.S.: Boilers 9 and 10 lose ignition, vibrate, have high draft and low CO_2

should be the same, and no trouble should be experienced.

Piney River, Va. IRA A. BUTCHER

Leaky Setting, Says Justice, and Shows How It Causes the Trouble

C. C. S. expressed concern over the fact that two of their natural-draft gas-fired boilers required an overfire draft of approximately 0.25 in. of water to keep the flame from going out, whereas the other seven boilers in the plant operated satisfactorily with an overfire draft of from 0.08 to 0.09 in. of water.

On these two boilers, if the overfire draft is cut down to about 0.10 in. of water, the flame begins to sputter or vibrate and may go out completely. This is a clear indication that the flame is not getting sufficient oxygen to support combustion. Sputtering or vibration of the flame is caused by so lean a fuel-air mixture that the flame is going out and re-lighting itself in rapid succession. This condition is extremely dangerous, because the flame may go out and stay out, and disaster may result if the fuel supply is not quickly cut off.

A leaky setting around the latter passes of the boilers is most likely to be the reason for the high overfire draft and low CO_2 on these two boilers.

Boiler room air, leaking into the latter passes of these two boilers, will appreciably reduce the amount of air brought in around the burner, where it should be brought in.

The stack produces a certain amount of draft or suction to draw the products of combustion through the boiler. If there are a number of air leaks in the latter passes of the boiler, boiler room air is going to be drawn into the gas passages between the combustion chamber and the breeching, with the result that less air will be drawn in around the burner.

Under such conditions, the flame will not receive sufficient air for perfect combustion, and sputtering or vibration indicates that the flame is barely able to maintain ignition. Increasing the rear damper opening will give a greater overfire draft (in this case, 0.25 in. of water is necessary) that in turn will pull more air in around the burner to make it burn satisfactorily. However, the increased draft of 0.25 in. of water will pull in even more air through the setting leaks, so that the combination of greater air around the burner and additional air infiltration dilutes the flue gases and lowers the CO_2.

When the overfire draft is reduced to approximately 0.10 in. of water, less air is pulled in the boiler setting and much less around the burner so that the flue gases are less diluted and the CO_2 reading is somewhat higher, but the flame sputters because of insufficient air. In spite of an apparent gain in increased CO_2 with 0.10 in. of water overfire draft, reducing the overfire draft is not the correct solution.

A careful check should be made of the settings of these two boilers to seal all cracks and to determine if air is leaking in through something that should be closed. (Yes—that happens sometimes!)

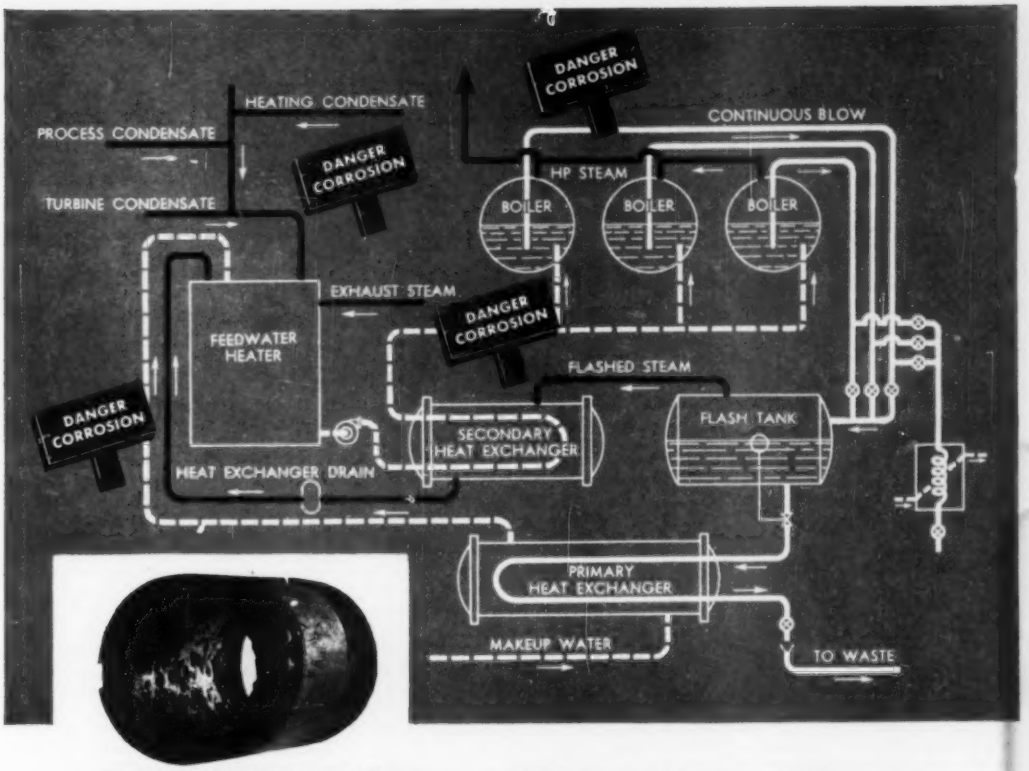
With natural draft, it is rather difficult to put the setting under a positive pressure to check for leaks. It may be necessay to build a smoky wood fire inside the furnace, close the stack damper tight, and use a portable blower to put a slight positive pressure on the setting. By noting where the smoke seeps outward through the casing, the leaks can be located.

Once the setting is made tight and all other leaks closed off, all the combustion air should enter around the burner ports under low overfire draft. Under these conditions, the flame should burn steadily and the CO_2 should be near normal for the type of gas fuel used.

Silver Spring, Md. WILLIAM C. JUSTICE

Check Loads, Fuel Supply, Setting, Draft Gages, Advises Cunningham

FIRST THING I would like to comment on will be the load conditions. I feel as though C. C. S. wants readers to understand that Boilers 1 to 7 are all right. Let us assume that the loads on these boilers are the same, how does he get the same draft with all? I feel that with No. 7 boiler being the farthest from the stack, its draft will have to be a little greater than the rest: No. 1 boiler should have the least draft



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WHAT AMINES ARE

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and No. 7 the greatest of this row of boilers.

As for the other boilers Nos. 8, 9, 10. If the boiler that is farthest away from the stack, No. 8, operates with a draft of 0.09 in., then the No. 9 and No. 10 boilers should operate with less draft, provided the load on each boiler is nearly equal.

If I were C. C. S., I would check the amount of fuel that is being burned in No. 9 and No. 10 as compared with No. 8 boiler. From here on, it would have to be a process of elimination to find the cause. Check furnaces on these boilers for leakage, draft gages, (to see if they are functioning properly) amount of fuel burned, height of water carried, cleanliness of tubes and shell.

It is a known fact that when the draft is reduced to a point of closing dampers, the fires will go out. Combustion cannot be maintained with a closed damper, so I feel that one of the causes may be the draft gages.

C.C.S. should take an Orsat reading of all his boilers, or if he doesn't have the equipment, call in a reputable combustion engineer and have all his boilers given a thorough check. But, as I have said before, he could go over one thing at a time and, in this manner, seek the source of trouble. Analysis by a good combustion engineer, however, might arrive at the proper solution sooner.
Philadelphia, Pa.

T. F. CUNNINGHAM

Answer No. 449

WHAT OPERATING DATA SHOULD BE LOGGED FOR A 1250 KW CONDENSING TURBINE GENERATOR?

This Log Records Performance of Operators as Well as Equipment

MR. MILLER and others have recommended log sheets in recent issues of POWER GENERATION, and they should be adequate to record the performance of this *equipment*. The accompanying turbine log was developed a few years ago for one of the Ordnance plants, for units of a different size, but is unique in that it also records the performance of the *operators*.

Boxes are provided for each shift to designate the units of equipment each one cleaned, oiled, inspected, or otherwise serviced. It is easy to remember the duty, easy to record the fact that it was performed, and easy for the "office" to know it was done. It saved me a lot of sleep on new plants with green crews!
Joliet, Ill.

D. M. CARR

CONTRACT TO FURNISH and install 14 large De Laval motor-driven centrifugal pumping units at the new Nottingham Pumping Station, Cleveland, Ohio, has been awarded Dravo Corp., Pittsburgh. The station, to be completed in 1951, will serve Cleveland's northeast section. Total capacity of the 14 De Laval pumps to be installed will be 204 mgd of treated water.

Pumps to be installed are as follows:

Service	Number	MGD each	Head
1st High	4	3	320 ft
2nd High	2	25	575 ft
2nd High	2	15	575 ft
Low	2	25	225 ft
Low	2	15	225 ft
Wash Water	2	16	52 ft

LETTERS TO THE EDITORS

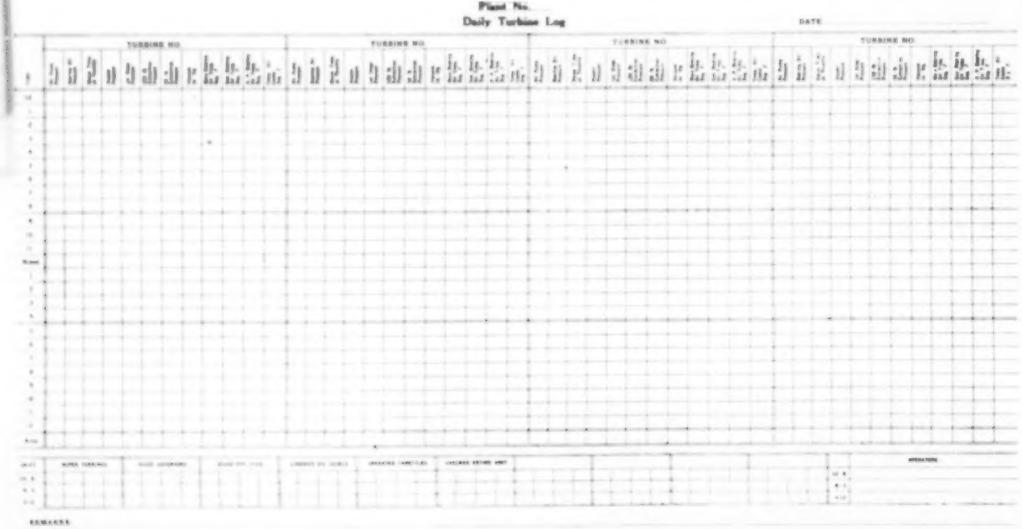
(Continued from page 69)

Of all the existing short-comings, granting that methods make for equality of results, is the effort to make it virtually impossible for those who want to work more to earn more, to have their desires squelched. This policy is of comparatively recent origin and the philosophy back of it is not even condoned in Russia where the Soviet incentive system is in effect.

It was noticeable at the New York World's Fair how certain local electrical men had to be present when foreign installations were put in, at full pay, since they were unable even with drawings, etc., to install equipment. The average contractor will even now pay premiums to a capable foreman or squad leader well above union rates due to the realization of his value.

There is much to be said on all sides but our far famed methods during the past 17 years, particularly "efficient methods" and "know how," have suffered to an unthinkable degree by the figment of "more pay for less activity resulting in a cheaper product." It just can't be done; the third law of motion about action and reaction is just as applicable to human endeavor as it is to the physical mechanism of the world. Just as it was said in India: "The first year one sits and thinks, the second year one just sits and for the third year one has assumed the horizontal position of completely supine atrophied inactivity."
Brooklyn, N. Y.

C. O. VON DANNENBERG



COMING EVENTS

ASCE—The American Society of Civil Engineers will hold its annual meeting at the Hotel Commodore, New York, Jan. 18-20.

ASHVE—The 56th annual meeting of the American Society of Heating and Ventilating Engineers will be held at the Hotels Adolphus and Baker, Dallas, Jan. 23-26.

AIEE—The Winter General Meeting of the American Society on Electrical Engineers will be held at the Hotel Statler, New York, Jan. 30-Feb. 3.

BCRI—The Bituminous Coal Research, Inc. will hold its annual meeting at the Netherland Plaza Hotel, Cincinnati, Feb. 9.

PEA—The Joint Mid-Winter Meeting of the Prome Movers and Electrical Equipment Committees of the Pennsylvania Electrical Association to be held at the Robert Treat Hotel, Newark, N. J., Feb. 23-24.

NPE—The National Production Exposition to be held at the Hotel Stevens, Chicago, April 4-8.

MPC—The twelfth annual Midwest Power Conference will be held at the Hotel Sherman, Chicago, April 5-7.

ASME—The Spring Meeting of The American Society of Mechanical Engineers will be held at the Hotel Statler, Washington, D. C., April 12-14.

AIEE—American Institute of Electrical Engineers to hold its Power Conference at the Wm. Penn Hotel, Pittsburgh, April 19. Power Generation; April 20, Industrial Power Systems.

ASME—The Semi Annual Meeting of The American Society of Mechanical Engineers will be held at the Hotel Statler, St. Louis, Mo., June 19-23.

ISA—The 1950 Instrument Conference and Exhibit of the Instrument Society of America, will be held in the Memorial Auditorium, Buffalo, New York from September 18-22.

Obituaries

L. E. BOGEN

L. E. Bogen, former engineer in the motor and generator section of Allis-Chalmers electrical department, died December 3, in Cincinnati.

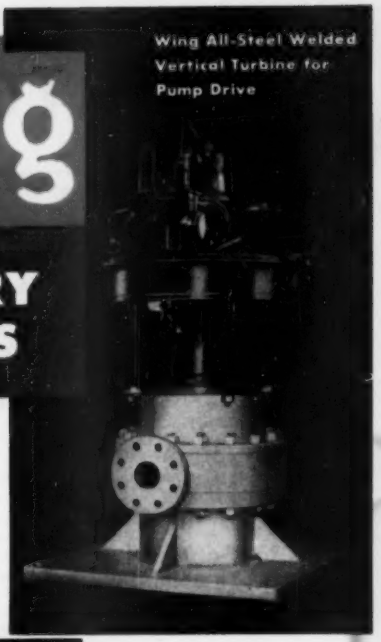
One of the pioneers in the electrical industry, Mr. Bogen received a degree in civil engineering from the University of Cincinnati in 1894 and a masters degree in electrical engineering from Cornell University in 1896.

He was a professor of physics at Ohio Mechanics Institute and at the University of Cincinnati before joining the Bullock Electric Manufacturing Co., Cincinnati, in 1901. In 1904, Allis-Chalmers acquired Bullock and four years later Mr. Bogen transferred to Allis-Chalmers Milwaukee works. He retired in 1947.

Specializing in waterwheel generator and synchronous condenser applications, Mr. Bogen was well known throughout the U. S. and elsewhere, having participated in many of the world's pioneer hydroelectric installations.

Wing

AUXILIARY TURBINES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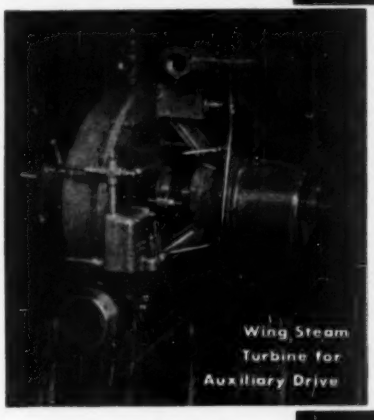
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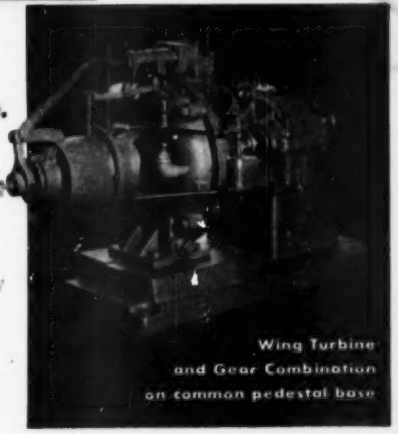

Wing Turbine and Gear Combination on common pedestal base

ATOMICS

The Bitter Wind

By ANDREW W. KRAMER

ONCE again, the bitter wind of hate, prejudice and party politics has blown across Washington, and once again, it has blown itself out with not too much damage except to our national dignity. The latest wave of hysteria might have been comic was it not inherently tragic; the fact that any cheap radio commentator or any publicity-seeking half-wit can gain so much national publicity on obviously groundless charges constitutes a sad commentary on the workings of democracy.

Last spring we went through the Hickenlooper farce and months were spent in sifting the evidence of gross mismanagement by the AEC which, of course, was not there, had never been there. As we pointed out in the July issue, after Senator Hickenlooper's slanderous attack on Mr. Lilienthal had been proved groundless, for the time being the issues lay dormant but not dead—sooner or later, we predicted, they would flare up and be whipped into another blaze of hysteria.

And they did. This time it was not David Lilienthal who was attacked; for the moment possibilities in that direction had been exhausted. This time, the muckrakers had to dig into the dead past for a flimsy excuse to discredit the Roosevelt administration. Absurd and preposterous as Racey Jordon's story was, it gained banner headlines in the newspapers throughout the nation, and once again, the average Tom, Dick, and Harry on the street was confused. That constitutes the real tragedy in these Washington farces—the public becomes more and more bewildered. Despite all the efforts of the scientists during the last four years to dispel the ideas concerning fundamental secrets of atomic energy, it still remains a great mystery to the general public and there are millions of people ready to believe the howlings of a Fulton Lewis, Jr. when he takes to the air.

Thanks to the calm, sane, and able testimony of General Leslie Groves before the investigating committee, Jordon's attempt to besmirch the characters of Harry Hopkins and Henry Wallace met with complete failure.

This great hullabaloo about a few pounds of uranium being shipped to Russia is in the same category with the frantic concern in the Hickenlooper investigation about the apparent loss of some uranium at the Argonne Laboratory some months ago. Whether the loss occurred or not, it was unimportant and so, also, would have been the shipment of a few pounds of uranium to Russia during the war. Uranium is important as a raw material in large quantities but a few pounds, even a few hundred pounds, would make no difference one way or another to any nation set upon developing atomic energy and certainly, there are no secrets about it.

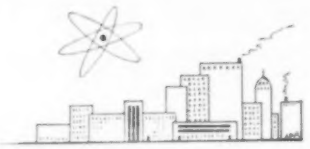
As the readers of ATOMICS well know, there are few secrets about atomic energy and the frantic efforts of stupid people in high public office to limit the free interchange of scientific data and what we call "know how" can only be to our detriment in the long run.

As pointed out in an excellent article in the December issue of Harpers Magazine by J. A. Campbell, assistant professor at Oberlin College, entitled, "How to Make an Atomic Bomb," our attempts to keep information to ourselves sometimes leads to the development of improved methods by other nations. This is well summarized in the testimony of Dr. Leo Szilard before a Senate Committee:

"We had a good method of which we were very proud, and we were not supposed to explain it to the Canadian Project. This annoyed our British friends. The result, however, I am told by two reliable scientists, was that they worked out a method for separating plutonium which is superior to the one we are using. It is both simpler and more complete."

This, says Dr. Campbell, is the nature of scientific "secrets." They are secrets which will be revealed to any ingenious researcher regardless of nationality.

It is tragic that those in the high places of our government too often do not understand this.



The above is the edito ial in the December issue of ATOMICS Magazine.

The new ATOMICS represents a greatly expanded service to those who are interested in the theory and application of nuclear energy. It will keep readers abreast of what is happening in the field of atomic power development, in the industrial applications of radioactive isotopes, and in the use of nuclear energy in medicine, biology and agriculture. The December issue, in addition to the article abstracted on this page, contains other material of atomic interest including the seventh installment of the course in Nuclear Power Engineering which started in the June issue.

If you are interested in seeing this new magazine regularly, send in the attached coupon for a free copy. You will be under no obligation for this. ATOMICS will be published monthly, and as has been true of the articles which appeared in the ATOMICS section of Power Generation, the articles will be kept on a practical, understandable level.

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- **Removal of Collected Material.**
- **Factors in Shell Construction (steel, concrete, brick, etc.).**
- **Operating Efficiencies and the Effect of Various Factors on Performance.**

. . . and many other basic Cottrell facts. Write for your free copy of Bulletin C103 today while supplies are adequate!

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POWER PLANT Construction News

Norwich, Conn.—State Dept. of Hospitals, State Capitol, Hartford, Conn., has authorized plans for new power plant at Norwich State Hospital, Norwich, for central-heating and other power service. Cost reported about $1,500,000, with equipment. Newman E. Argraves & Associates, 70 College St., New Haven, Conn., are consulting engineers.

Palatka, Fla.—Florida Power & Light Co., Ingraham Bldg., Miami, Fla., has plans maturing for new steam-electric generating station on St. Johns River, near Palatka, with initial capacity of 66,000-kw, divided into two 33,000-kw units. Cost reported close to $10,000,000, with power substation, transmission lines and other operating facilities.

Tallahassee, Fla.—City Electric Dept., Park and Adams Sts., has authorized plans for new municipal steam-electric generating station on St. Marks River, reported to cost about $5,000,000. Reynolds, Smith & Hills, 227 Park St., Miami, Fla., are consulting engineers.

Chicago, Ill.—Central Waxed Paper Co., 5659 West Taylor St., waxed and other processed papers, plans boiler house for central-heating and other service at proposed new plant on Roosevelt Blvd., near Laramie Ave., totaling over 150,000 sq ft floor space. Entire project reported to cost about $1,000,000. Battey & Childs, 231 South La Salle St., Chicago, are engineers.

Pontiac, Ill.—State Dept. of Public Works & Buildings, Armory Office Bldg., Springfield, Ill., has approved plans for new addition to power plant at institution at Pontiac, including installation of equipment for increased capacity. No estimate of cost announced. Will begin work soon. Nelson & Nettnin, Inc., 343 South Dearborn St., Chicago, is consulting engineer.

Fort Dodge, Iowa—Certain-Teed Products Corp., Ardmore, Pa., plans power house at new wallboard-manufacturing plant at Fort Dodge, comprising several large buildings for processing and general production. Entire project estimated to cost close to $2,000,000. Work will begin soon.

Ottumwa, Iowa—Ottumwa Hospital Association, Ottumwa, George M. Foster, chairman of building committee, plans boiler plant for central steam-heating service in new multi-unit hospital on 60-acre tract of land. Entire project will cost about $1,500,000. Proposed to ask bids soon. Morgan & Gelatt, F. & M. Bank Bldg., Burlington, Iowa, are architects.

Hagerstown, Md.—City Council, City Hall, will have plans prepared by Albert C. Woods & Associates, Stock Exchange Bldg., Philadelphia, Pa., consulting engineers, for proposed extensions and improvements in municipal power plant, with installation of equipment for increased capacity. Bond issue of $1,500,000 has been authorized for project.

Minneapolis, Minn.—Northern States Power Co., 15 South Fifth St., is arranging an appropriation of about $30,000,000 for expansion and improvements in power plants, power substations, transmission and distributing lines in 24-month period, 1950-1951. This will be a continuance of program which has been under way during 1949, representing an investment of close to $42,000,000, to date.

Johnstown, N. Y.—New York State Electric & Gas Corp., Binghamton, N. Y., has approved plans for new steam-electric power plant at Johnstown, to be known as Goudy Station, reported to cost approximately $7,500,000, with power substations, transmission lines and other operating facilities. Contracts for general construction are expected to be awarded soon. Gilbert Associates, Inc., 412 Washington St., Reading, Pa., is consulting engineer.

Fairfax, Ohio—Ford Motor Co., Dearborn, Mich., plans power house at proposed new branch assembling plant on Red Bank Rd., Fairfax, near Cincinnati, totaling about 400,000 sq ft floor space. Entire project is reported to cost close to $5,000,000. Proposed to begin work soon.

Eugene, Ore.—Sacred Heart Hospital, Sisters of St. Joseph, Eugene, plans boiler plant for central-heating service in new hospital on local site. Project will comprise several buildings and is reported to cost approximately $2,000,000. John W. Maloney, Central Bldg., Seattle, Wash., is architect.

Pittsburgh, Pa.—H. J. Heinz Co., Inc., 1062 Progress St., Northside, prepared food products, plans extensions and improvements in power house at plant, including installation of equipment for increased capacity. Peter Loftus, First National Bank Bldg., Pittsburgh, is engineer.

ASME Holds 70th Annual Meeting

WHILE the technical sessions of the annual ASME meeting have lost none of their importance or interest for the members who attend, the mechanical engineers, like all other branhes of the profession, are beoming increasingly concerned with the non-technical factors affecting them as individuals and citizens.

This was well illustrated at the 70th Annual Meeting of the Society held November 28 to December 2 at the Hotel Statler, New York City, and attended by approximately 5000 members of the organization. Great interest was manifested in sessions dealing with the possibility of improving management-labor relations; the education of engineers; their integration into the profession and their prospects for the next few years; the place of women in engineering; the obligation of management to provide leadership; and similar problems.

At the management luncheon, the Gantt medal for 1949 was presented to Arthur C. Spurr, president of the Monongahela Power Co., in recognition of his leadership in revitalizing the social and economic life of the area of his influence. That activity has been attracting much attention in the power industry for some time; to have it thus publicly acclaimed is very heartening and pleasing to the whole field.

Reheat Economics

Among the technical problems for power engineers, reheat cycles were discussed in detail. R. P. Moore, in a paper on Investment Costs of Reheat, compared cost data on recent reheat and non-reheat installations. On the basis that the cost of power plant equipment does not vary with its size but nearly as the factor 0.7, credits and debits for the two cycles showed a credit of $2.16 per kw for reheat against a debit of $3.88 per kw, making a net additional charge of $1.72 per kw for the reheat cycle. This must be balanced against operating savings through higher efficiency.

R. W. Hartwell and H. A. Wagner compared four installations and concluded that the reheat installation appears favorable economically in all cases, although, if 100 per cent capacity charges are assigned and annual plant factors of 60 per cent or lower are used, the savings in favor of reheat are considerably reduced. R. C. Dannettel and G. S. Harris reviewed the factors in a comparison of reheat and non-reheat cycles that showed many advantages in selecting a 1450-psig, 1050-F straight condensing unit for a particular station.

Possibilities of the Regenerative Steam Cycle at Temperatures up to 1600 F were treated by P. H. Knowlton and R. W. Hartwell. A method of evaluating steam power plant losses by means of the entropy balance diagram was explained by Allan Keller. J. D. Yoder, W. L. Webb and T. Baumeister presented a paper showing how increased power production can be obtained by exhausting high-pressure turbines direct to process rather than to coils of evaporators used to produce process steam. An important factor in this gain is the use of properly-treated boiler make-up.

Combustion of Pulverized Coal

Effect of Pressure on Combustion of Pulverized Coal, a paper by T. T. Omori and A. A. Orning, showed how decreased initial heating rates under higher pressures lead to less complete combustion, despite the beneficial effects of using oxygen. H. Perry, R. C. Corey and M. A. Elliott described gasification of pulverized coal with oxygen and steam.

Two papers, one by E. C. Russell and the other by J. N. Ewart, dealt with the experiences of two electric utilities in adopting bulldozer-carry-all units for storing and reclaiming coal.

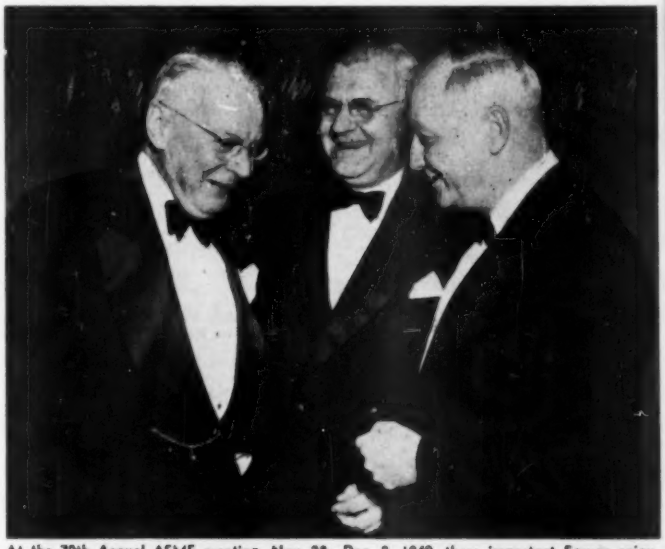
A symposium on uses and disposal of fly ash brought out the fact that industry has been making considerable use of it as a partial replacement of Portland cement, as a fine aggregate in cinder concrete, in bitumastic road construction, in thermal insulating cement and in special sand blasting.

Experiences with potassium sulfite decomposition and silica deposition resulting from boiler feedwater at Springdale were related by L. E. Hankinson and M. D. Baker. Professor F. G. Straub reported on a form of sodium phosphate hide-out in 1700-psi boilers that differs from normal hide-out.

Three European closed-cycle gas turbine installations were described by Curt Keller, while George R. Fusner described heat exchange equipment for a 5000-kw gas-turbine generator. Progress reports were given on the experimental stationary coal-fired gas turbine unit of LDC at Dunkirk, which had operated continuously on coal for 40 hr up to meeting time; also on the performance of the Union Pacific's Bunker C oil-fired gas turbine locomotive now in commercial service.

Hydraulic performance of centrifugal and axial flow compressors was covered by A. J. Stepanoff, who explained how and why the relations between head-capacity-speed and physical dimensions are determined completely from the velocity considerations.

Influence of wear and operating conditions in Francis and impulse type hydraulic turbines was discussed by A. Puyo, and an illustrated description of a 62,000-hp vertical impulse turbine under 1118 ft head was given by W. F. Boyle and I. M. White.



At the 70th Annual ASME meeting, Nov. 28—Dec. 2, 1949, three important figures enjoy a good story. Left to right:—James D. Cunningham, president, Republic Flow Meters Co., incoming president of ASME for 1950; Clarence E. Davies, ASME secretary; James M. Todd, consulting engineer, New Orleans, ASME 1949 president

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Plan now to exhibit and sell your products at the 49th Annual National Power Show. Thousands of engineers will be there who buy, specify and recommend power production, power generation, power transmission and materials handling equipment, materials, supplies and services.

Many exhibitors signed up for the 1950 show before the 1949 show closed. The 49th Annual Show is certain to be a "sellout." Write today for floor plan so you can place your reservation at once. Space is assigned in order of receipt of reservation agreements.

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Babcock & Wilcox Co.
Bushnell Packing Company
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Dowell, Inc.
Electric Auto-Lite Co., The
Fairbanks, Morse & Co.
Garlock Packing Co.
Green, A. P., Fire Brick Co.
Jefferson Union Company
Link Belt Company
Livingstone Engineering Co.
Lunkenheimer Company
Milwaukee School of Engineering
Otis Elevator Company
Parfax Corporation
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Power & Operating Eng. —McGraw-Hill
Ramfite Co., Div. of Obermayer Co.
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A nine page statistical analysis of attendance at the 1949 National Power Show will be sent on request. This analysis breaks down the thousands of registrations by state, city and foreign countries; by position and executive title; and by industry. This registration analysis proves that every manufacturer who serves the power field will profit by exhibiting in The 49th Annual National Power Show to reach this valuable audience of customers and prospects.

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CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS AND AUXILIARIES

201 Working Pressure Data Card—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart covers 2 letter-size pages, is printed on firm stock, and punched for use in binder. The Babcock & Wilcox Tube Co.

202 Blast Furnace Gas Burner Bulletin—Said to be the first published on the subject. Bulletin No. 500, 4 pp, describes operation of these burners and discusses their adaptability for use not only with waste fuels, but also in combination with auxiliary fuels and by means of auxiliary fuels alone. Contains pictures of gas burner installations and cross section drawings of various other types of burners for waste and primary fuels. Peabody Engineering Corp.

203 Water Tube Boilers—This 12-pp bulletin illustrates and describes special and standard power plant boilers and packaged steam generators. Includes data and dimensions. Springfield Boiler Co.

VALVES, TRAPS, PIPING

204 Pipe Distribution System Data—"Engineering Distribution Data for Underground Steam Distribution," is the title of Section 480-2, 34 pp, of practical usefulness to those who deal with problems involved in insulated piping distribution systems. It covers layout of the route and methods of estimating steam loads, includes steam flow charts and tables, and gives properties of steel pipe, copper water tube piping and saturated steam. Also gives specifications of steam and hot water distribution piping with prefabricated pipe conduit. It's illustrated with photos of field installations and industrial applications of insulated pipe units, also sketches showing method of making field closures. The Ric-Wil Co.

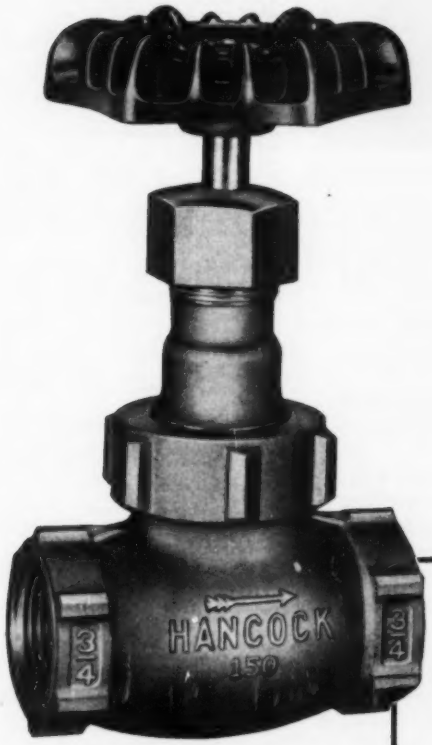
205 Piping Materials Catalog—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

206 Steam Specialties—Here is a collection of bulletins covering manufacturer's line of thermostatic steam traps, inverted bucket steam traps, float-thermostatic steam traps, radiator traps and valves, alternating receivers and lift traps, self-operated temperature regulators, air venting equipment, water blenders, strainers. All equipment is illustrated by photos, its operation and applications discussed, and its capacities, dimensions and prices listed. Sarco Co., Inc.

207 Pipe Hanger Catalog—Ninety-page Catalog 10-D is a valuable buyer's guide for adjustable pipe hangers and supports. Covers hangers for attachments to pipe and to structure, hanger assemblies, spring hangers, hanger rods, pipe supports and related equipment. Each type described and illustrated by photo and di-

ANNOUNCING!

The New 150# Hancock "500 Brinell" Bronze Valve

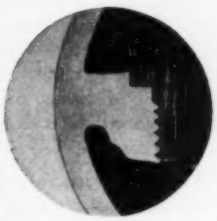


Diaphragm construction of new 150# Hancock Bronze Valve 125% to 230% stronger than found in usual bronze valves.

300# Valve Results at 150# Valve Prices!

"Super-Tough" is the word for the new 150# Hancock "500 Brinell" Bronze Valve. With a diaphragm construction equal to a 300# bronze valve, real strength and rigidity are built into this new bronze valve. Super-finished "500 Brinell" stainless steel seats and discs prevent leaks, cut maintenance cost to a minimum. Note the extra-rugged structure that means top ability to withstand expansions in piping systems, strains from installation and piping. Save money, increase efficiency, stop leaks. Install new 150# Hancock Bronze Valves.

For complete information, see your local distributor



Usual bronze valve diaphragm

Hancock diaphragm

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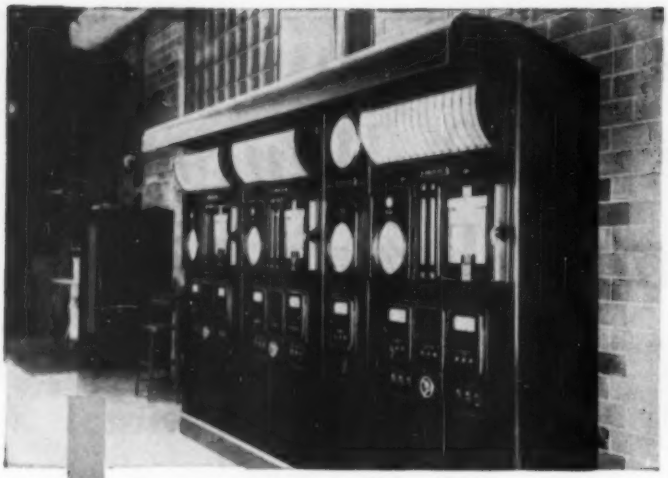

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QUICKLY PAID FOR ITSELF

How to get more steam to meet the demands of steadily increasing production, with all three boilers in continuous operation: that was the problem at General Mills' plant in Paris, Illinois.

A Hays Automatic Combustion Control System with full instrumentation was installed—and the problem ceased to exist. Production went up sharply from 12,500 bushels per day using three boilers, to 22,500 bushels per day using only two boilers—with the third for standby. Combustion is smokeless, velocity of gases was reduced, operating pressure is higher and turbine steam consumption dropped 1000 pounds per hour. CO_2 averages 15 percent as against the previous 7 percent; boiler efficiency rose from 55 to 78½ percent. Steam costs dropped sharply. The Hays system quickly paid for itself.

Records like this of Hays performance are not exceptional; and indicate that it's good business to *find out* about this modern electrical system, to investigate *what it will accomplish for you* in improved production and lower costs.

Talk over your plant's steam requirements with a Hays engineer—no obligation, of course. And write for Publication 47-605: worth reading.

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mensional diagram and listed with dimensions and prices. Catalog also includes standard specifications, photos of installations and terms of sale. Indexed for quick reference; punched for filing in binder. Grinnell Co., Inc.

208 Valves Bulletin—A new catalog section 12-H describes all types of the company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensioned line drawings. A standard materials specification table is presented. Edward Valves, Inc.

209 Rubber Expansion Joints — This 8 page bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Other information given, includes "How To Order" and a table of dimensions which is accompanied by dimensioned line drawings. The bulletin is well illustrated. The Garlock Packing Company.

210 Control Equipment—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

211 Flanges for Severe Service — This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber pipe for use with abrasive or corrosive material, as well as an acid- and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

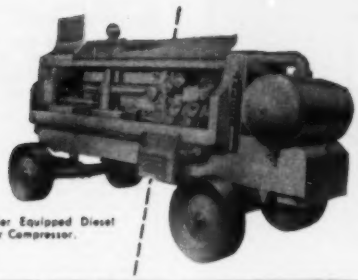
HEATERS, HEATING

212 Fan Heater Bulletin—Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page contains a sketch in color showing how the heater works. Niagara Blower Co.

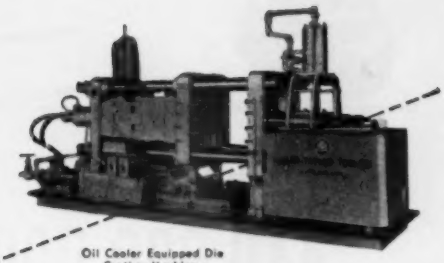
213 Space Heaters—Bulletin 523, 12 pp, covers forced air space heaters, direct-fired by oil, gas or combination fuel and ranging in output from 400,000 to 2,000,0000 Btu, for comfort heating, year-round ventilating, tempering make-up air, process drying and heat curing. It discusses their design and principle of heat distribution and lists 18 reasons why these heaters are recommended for open space heating. Includes specifications, capacity and dimension tables, sketches illustrating operating principles and construction details and photographs showing the heaters in use. Dravo Corp.

214 Packaged Heat — Unit heaters featuring low first cost, easy installation and continued low cost per Btu are presented in this 12-pp booklet. Text explains how these packaged heaters are designed to operate instantly on oil or gas, fit heat output to requirements of day, and provide heat where it's wanted. Illustrations include photos of heaters and several installations and many sketches showing advantages and construction details. Pratt-Daniel Corp.

215 Tubular Heat Exchangers—Bulletin 916, 32 pp, is highly informative. The bulletin describes the present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are fully explained, together with statements of the particular services for which each is suitable. An additional helpful feature of the bulletin are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presented are charts of specific heats of midcontinent crude oils and for solving MTD formula with correction factors



Oil Cooler Equipped Diesel Air Compressor.



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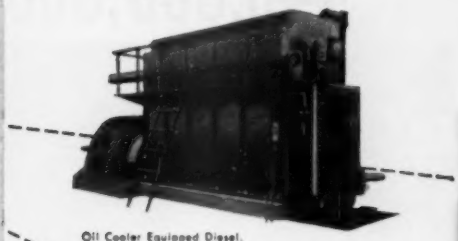
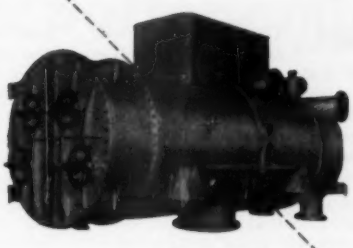
As both machinery manufacturers and users well know, Ross' complete standardization and mass production of smaller size exchangers enable the immediate shipment of many units from stock and the immediate assembly of many others from stocked parts. The net result is extensive use of Ross exchangers as original accessories by the Diesel, hydraulic machinery and like industries.

But the time-saving, cost-saving benefits of Ross standardization are not limited to size and type. Many apply to even the most specialized of custom-engineered exchangers. For having completely standardized and carefully classified all essential components of such larger, more complex equipment as power plant surface condensers, refinery heat exchangers*, high pressure bleeder heaters or mammoth fuel oil heaters . . . Ross can eliminate many of the engineering and fabricating costs and delays commonly associated with specially engineered units.



Oil Cooler Equipped Diesel.

High Pressure Bleeder Heater.



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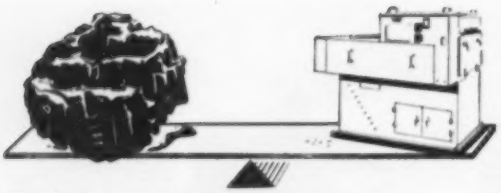
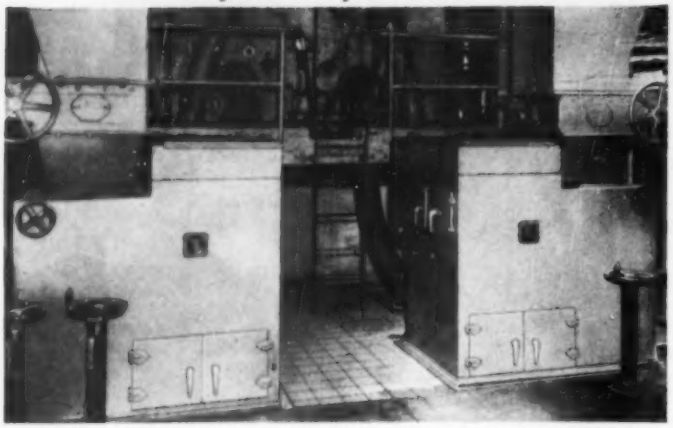


helping balance a

440,000,000 ton-diet



Two Richardson 200 lb. Coal Scales at Rockland Light and Power Company's new Hudson Plant.

The total annual rated capacity of Richardson Coal Scales serving steam generating plants in public utilities and industrials is greater than the estimated 440 million tons of coal consumed industrially throughout the nation last year.

Leading surveys of latest developments in central station and industrial power plant design trends emphasize the importance of fuel economy. When it comes to checking coal consumption the reasons for preference for Richardson Scales are obvious. By weighing every ounce of coal accurately to ¼ of 1%, day in and day out, they provide a positive check on coal used in relation to power produced...identify wasteful boilers and permit correction of inefficiencies before fuel losses become serious. Thus they contribute importantly to lower power costs.

The extensive Richardson line of equipment for weighing, conveying and feeding coal includes a model ideally suited to your space layout and capacity requirements... stationary floor-mounted models, stationary and portable models mounted at mid-section, and combination conveyor and elongated scales. Dust-proof, pressure-tight housing contributes substantially to plant cleanliness.

Why not trust Richardson's unrivalled experience—50 years old—to weigh your coal from bunker to stoker (or pulverizer)? Hundreds of public utilities, municipalities and industries do.

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for other than countercurrent conditions. The Griscom-Russell Co.

216 Chemical Soot Removal — Ten-pp Bulletin 43, on the chemical removal of soot from boiler furnaces, explains the research work that led to the development of manufacturer's new chemical soot remover and slag alleviator for coal fired boiler furnaces. It tells how this combustion catalyst prevents soot formation on furnace internals and helps to end the smoke problem. National Aluminate Corp.

217 Water Heaters—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most pressures. Davis Engineering Corp.

218 Tubular Heater—A simplified vertical tubular heater suitable for every process duty and designed to hold initial and maintenance costs to a minimum, is the subject of 4-pp Bulletin 0-49-7. Includes a complete description of this simplified design which features the use of bare tubes and the absence of any metal parts exposed to furnace gases, also a discussion of the design's advantages. Cutaway drawings illustrate text. Foster Wheeler Corp.

219 Condensate Drainage Control — Manufacturer's system of high-pressure and high temperature condensate drainage control is fully explained in 24-pp Publication No. 3250. Contains useful data on steam flow conditions and heat exchange characteristics. Gives material and operating specifications and capacity ratings for both standard and high differential units in six sizes from 3 to 25 hp based on a maximum of 200 psi above process pressure. Differential pressures to 200 psi are listed and capacities for each unit tabulated for unit inlet pressures. Illustrations include photographs and dimensional drawings in color showing design and construction of both types of units. Cochrane Corp.

TREATMENTS, PREVENTIVES

220 Water Conditioning Bulletin—This is an eight-page discussion of water and chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

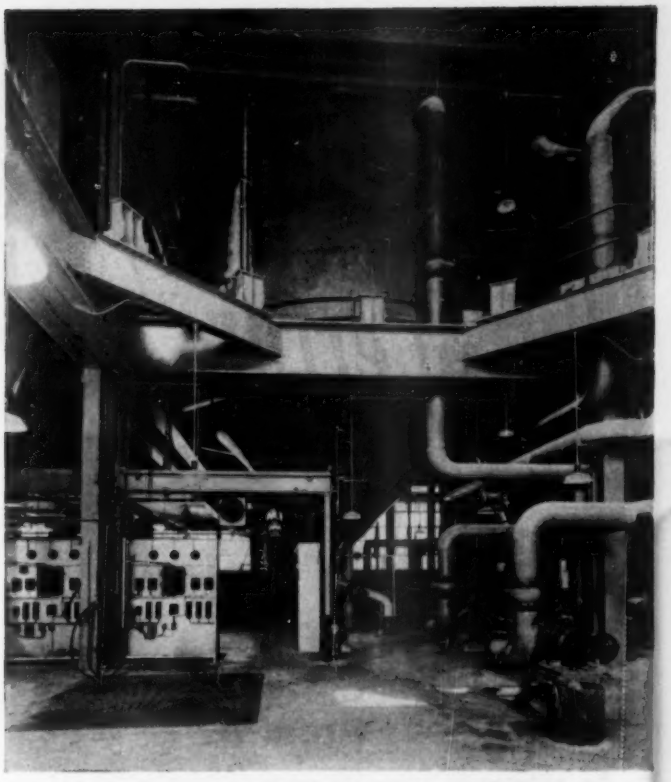
221 Corrosion Analysis—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

222 Corrosion Resistance of Nickel Alloys—Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 26 tables and 33 graphs and photos in addition to text. Problems involving a wide range of operations from the pickling of steel to petroleum refining and textile processing are covered. The International Nickel Co., Inc.

223 Cleaning Industrial Equipment—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

224 Anti-Foam Treatment — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the

One of the two 85,000 gph GRAVER Hot Process Softeners installed at Indianapolis Power & Light Co. The photograph shows the lower portion of the sedimentation tank inside the building.



"Success Story" of GRAVER

Hot Process Water Softeners

This GRAVER "Success Story" took place at the Indianapolis Power & Light Co. Five Hot Process Softeners of another make were being used, but a more efficient central installation was desired. A single GRAVER unit was installed to replace the five existing older units. When the plant was later expanded, an additional GRAVER Softener was installed. These two GRAVER Hot Process Lime Soda Softeners have a combined capacity of 170,000 gph, and are treating feed water for boilers operating at 625 psig and 750°F.

The thorough effectiveness of this GRAVER installation is shown in the following results: The raw water hardness of 290 ppm is reduced to less than 15 ppm with excess soda ash of 25 ppm and causticity of approximately 10 ppm (all as $CaCO_3$). An effluent turbidity of less than 8 ppm results in minimum filter back-washing.

And here's another GRAVER advantage to remember. All major component parts of the Softeners were fabricated in the GRAVER shops, and the units were erected and initially operated by GRAVER, providing a single responsibility for the entire job.

A new GRAVER bulletin explaining the functions, principles and applications of Hot Process Softeners and the distinctive features of GRAVER designs is now available. You will find it particularly informative and helpful. Write for your copy today.

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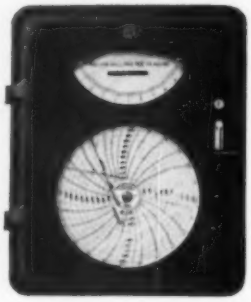

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problem of steam contamination and explains the action of this polyamide antifoam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

225 **Boiler Corrosion**—A 12 page article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables aid in understanding the article. W. H. & L. D. Betz.

226 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 28B7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. Allis-Chalmers Mfg. Co.

227 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Illustrations include photographs of two feeders and diagrams of the various methods described. Punched for filing in ring binder. Proportioneers, Inc.

228 **Water Softener Equipment** — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener to show how an ion exchanger is built and how it works. Bulletin also contains flow diagrams showing arrangements for installation of water softeners and includes detailed, illustrated discussion of multiport valves used in them. The Permutit Co.

229 **Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering a recently developed amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free CO_2, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures. The Bird-Archer Co.

230 **Chemical Feed Systems** — Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps and a typical packaged installation. Milton Roy Co.

ELECTRICAL

231 **Electrical Diagram Guide**—The purpose and use of electrical diagrams supplied with switchgear equipment are explained in Bulletin GET 1293A. It was written to help those who install, operate or maintain switchgear equipment make the best use of the diagrams that come with such equipment. Discusses in detail one-line, elementary, connection and interconnection diagrams. It tells their scope and uses and illustrates symbols used and

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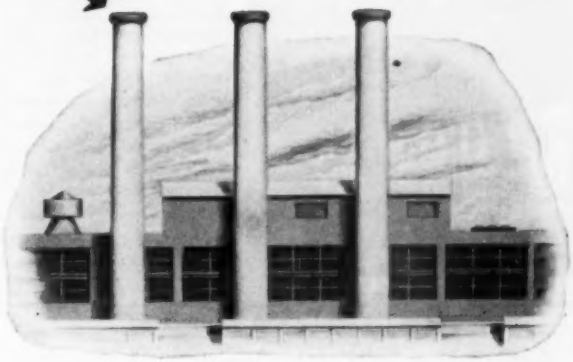

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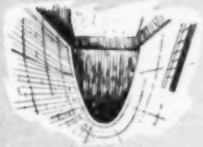
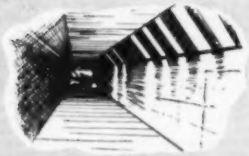
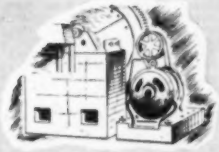


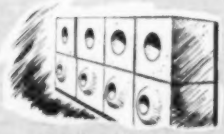
Coal Bunker Linings



Flue and Duct Linings



Overnight Structural Concrete



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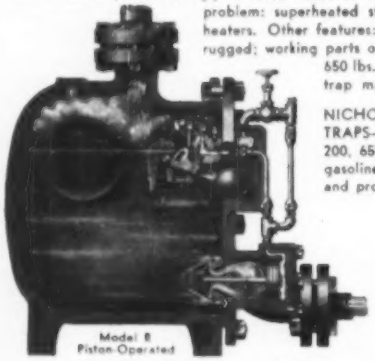

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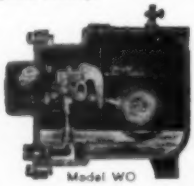

Model WO

Catalog 448 or see Sweet's

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common variations and explains ASA device function numbers and conventions. General Electric Co.

232 Transformer Buyers Guide—An excellent technical manual on instrument transformers is this 80-page catalog, GEA-4626B. Contains descriptions, photographs and index of ratings and construction for indoor and outdoor potential transformers, indoor and outdoor current transformers, outdoor metering outfits and portable potential and current transformers, according to cycles. Dimensions, prices and shipping weights are included with listing of each type, as is reference to manufacturer's bulletin dealing with that type of transformer. Index of types shows voltage and frequencies. Also included are tables showing mechanical and thermal limits of current transformers. Book has firm covers and ring binding for long-time reference use. General Electric Co.

233 Synchronous Generators—This Bulletin, 05B6139A, describes construction features and electrical characteristics of engine-type synchronous generators in standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 600 rpm, for Diesel, steam, or gas engines. Also describes and illustrates mechanical construction of stators and rotors and discusses machine characteristics, ratings, voltages, frequencies, phases, temperature rises and operation at high elevation. Illustrations show typical installations. Available control accessories are listed, as are manufacturer's other products and territorial sales offices. Allis-Chalmers Manufacturing Co.

234 Synchronous Motors — High speed synchronous motors are described in this recently-issued 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

235 Mechanical Rectifiers — Presenting mechanical rectifiers as a simple solution to the problem of low voltage power conversion, Bulletin 4809, 12 pp, covers their history and advantages, using charts and graphs as evidence of their inherent high efficiency. Also provides an illustrated explanation of rectifiers' operating principles. I-T-E Circuit Breaker Co.

PUMPS, COMPRESSORS, ENGINES

236 Steam Engine Governor Data—This new bulletin No. 502, describes the company's Type EN fully enclosed self-lubricated governor which is described as giving "precise, dependable engine speed control." Illustrations of the unit are presented and a parts list, accompanied by a sectional diagram is given. One section "Installation and Care" tells how to assemble governor to engine cylinder and how pulleys should be proportioned, the proper type of belt for use with the governor, correct lubrication procedure, method of packing and other data. Troy Engine & Machine Co.

237 Condensers—Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

238 Compressor Selection Chart—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

239 Air Compressor Lubrication Manual—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated with large, clear photographs and drawings showing construction and operation of compressors,

their lubricating systems, etc. Cities Service Oil Co. (In the South, Arkansas Fuel Oil Co.)

240 **Steam Pumps** — This is manufacturer's collection of bulletins covering all types of centrifugal and reciprocating pumps for a wide range of industrial uses. Contains more than 80 pp in all and includes photos, dimensions, specifications, ratings and application data. Warren Steam Pump Co.

INSTRUMENTS AND CONTROLS

241 **Smoke Density Recorder** — Bulletin 211, 4 pp, tells how company's bolometer-type smoke density recorder promotes efficient furnace operation and how it helps in the battle against smoke nuisance. It describes and illustrates the smoke detector which consists of a bolometer receiving and measuring radiation from a sealed beam light source. Recorder specifications, installation requirements, and measuring circuit details are also discussed. Bailey Meter Co.

242 **Boiler Water Level Control** — Bulletin 487 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. A large, full-page cross section of the B & W Type FH integral furnace boiler is presented and other drawings and photographs show the accompanying equipment. Northern Equipment Company.

243 **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

244 **Instrument Handbook**—"Modern pH and Chlorine Control" is a 100-pp catalog containing a great deal of valuable information in addition to covering manufacturer's line of scientific instruments and accessories. It explains the meaning of pH control, the electrometric and colorimetric methods of determining pH, and gives values of common acids, bases and foods, as well as maximum capacities of buffer systems. It also discusses in detail the applications of pH and chlorine control in air conditioning, water treatment, boiler water and many other industrial applications, recommending instruments and solutions. Instruments are illustrated by photograph, their functions described and prices given. W. A. Taylor & Co.

245 **Temperature Measuring Instruments** —For all those responsible for the safe operation of electric power equipment, this company has just issued a revised 34 page catalog ND4-33-4F describing the company's instruments for measuring the temperature of generators, motors, condensers, transformers, etc. The bulletin covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

246 **Recording Instrument Data Book**— An oxygen-analyzer, based on the para-magnetic property of oxygen, is described and illustrated in Bulletin 49-829, 16 pp. Tells advantages and applications of the instrument; also discusses manufacturer's analyzer for carbon dioxide and other gases and an electronic recorder (temperature and pressure) for use with analyzers. Describes several recommended gas sampling systems. The Hays Corp.

247 **Metering Chlorine** — Bulletin 640-F2 describes an instrument designed to accurately meter chlorine gas and deliver a chlorine water solution to the point of application. Discusses the safety and other features of the instrument and explains its operation and maintenance. Illustrations include photos, a phantom drawing showing principle working parts, and a layout diagram. Builders-Providence, Inc.

248 **Purity Indicator**—An instrument for measuring and indicating electrical conductance of steam and water is described and illustrated in 6-pp Bulletin 11-23-48 RCU. It discusses problems encountered with steam and condensate purity and cites examples of how controller and alarm assembly are utilized in detecting and signalling impurities caused by carry-

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MATERIALS HANDLING

249 **Dry Materials Conveyor** — Bulletin F-H-1 describes this company's revolutionary type of conveyor designed for the handling of fine, dry materials. The book, which contains 12 pages, presents excellent installation views of the conveyor, and also drawings which illustrate construction and method of operation. The bulletin points out that the conveyor has no moving parts and that it has no hazards to workmen, is silent in operation, requires no lubrication and can pass around obstacles. Fuller Company.

250 **Screw Conveyor**—Two-pp Form A-84 describes a high-speed, direct-feed, bin-to-stoker screw conveyor that comes ready to set up. Illustrations show this conveyor in use and detail of its principal parts. Stresses economy of this conveyor in handling coal and includes specifications. Baughman Mfg. Co., Inc.

COAL HANDLING

251 **Coal Scale Data Book**—The answers to a power engineer's questions on coal scales are provided in this excellent 48-pp book, Bulletin 1143, covering scales for recording weight of coal consumed by individual boilers and weight of coal receipts from ship, car, truck or storage. It is generously illustrated with photographs of models and accessories and actual plant installations and contains all necessary engineering drawings, dimensional data and detailed specifications. Construction features and operation of weighing and feeding systems are described. Richardson Scale Co.

252 **Spreader Stoker Selection** — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of typical installations. American Engineering Co.

253 **Coal Crushing, Sizing** — Bulletin 3007 describes the company's Bradford breaker a coal crusher, sizer and scavenger. The bulletin presents drawings of the breaker, tells how it works and then presents the complete story of its operation at the coal mine and coal cleaning plant at the By-Product Coke Plant and at the Power Station. The back section of the catalog presents engineering information on capacities, dimensions and dimensioned line drawings. Pennsylvania Crusher Co.

254 **Coal Crusher**—In this 8-pp bulletin a rolling ring crusher is presented as a solution to the problem of uniform stoker coal. Describes the special features of this crusher, emphasizing its shredder designed to split coal rather than crush it. Gives speed, capacity, weight and dimensions of available models and illustrates principle of operation. Also contains photos of parts and several complete installations. American Pulverizer Co.

255 **Underfeed Stokers**—Buletin 350, 24 pp, features a single retort underfeed stoker which may be operated by electric or steam drive. It is described as a complete firing unit for burning various grades of bituminous coal with high efficiency for boilers from 50 to 150 hp rated capacities. Generously illustrated, the bulletin explains the operation of these stokers, tells their applications and economy and gives sizes and capacities. Also contains installation photos and diagrams. Detroit Stoker Co.

TURBINES

256 **Turbine Catalog Collection**—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

257 **Velocity Stage Turbines** — Catalog 82-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart show-

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ing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts. Speed governor and regulating valve, and emergency governor and trip valve are described in detail. De Laval Steam Turbine Co.

258 **The Answers on Turbine Oil**—This 12-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Explanations are brief but thorough. Booklet is illustrated with photos of turbine installations in which manufacturer's products have been used successfully. Standard Oil Co. (Indiana).

MISCELLANEOUS

259 **Pump Packings**—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

260 **Cooling Towers**—Double-flow cooling towers are featured in 20-pp Bulletin DF. It discusses the principle of double-flow cooling, the mechanical equipment utilized, construction features of a tower of this type, water distribution, coil shed, and safety factors. Recommends sizes for different applications and includes photos of many installations. The Marley Co., Inc.

261 **Concrete Floors Q & A** — A new booklet titled Lumnite Concrete Floors—Corrosion Resistant and Heat Resistant, has just been published. The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to a number of questions often asked about it. A section on placing and finishing corrosion resistant floors will be helpful to prospective users. Lumnite Division, Universal Atlas Cement Company.

262 **Application Data Bulletin** — Titled "The Aroclors," chlorinated biphenyl and chlorinated poly-phenyls, this booklet describes the unique properties which enables this material to fulfil certain requirements. The Aroclors have won a place in the electrical insulating field and in such widely differing applications as non-flammable hydraulic media, high-temperature and high-pressure lubricants, heat-transfer and expansion media, sealing compounds, adhesives and protective coatings, including plastics, pigments, lacquers, paints and varnishes. This booklet contains 28 pages and presents the combined information gathered by the company from what it believes to be reliable and dependable sources. Monsanto Chemical Co.

263 **Tube-Ice Machine** — Bulletin TI-3 describes manufacturer's automatic ice-making machine for producing either cylinder or crushed ice. Explains and illustrates machine's operation, discussing its small space requirement, quick freezing time, reduced power consumption and economy. Its application in the dairy and packing industries, breweries, chemical plants, institutions, and ice plants are described and pictured. Also discussed is the utilization of this machine in cold water refrigeration for air conditioning systems. Includes chapter on the handling and storage of ice. Henry Vogt Machine Co.

264 **Purger Bulletin**—How air and other non-condensables get into refrigeration systems; the adverse effect of this on operating costs and efficiency and what manufacturer's forged steel purger does to prevent it are covered in 4-pp Bulletin 192. Also included are installation data with illustrations and diagrams, specifications and prices, helpful charts and tables. Armstrong Machine Works.

265 **Intake Filters** — Manufacturer's line of intake filters of the "dry" type for combustion engines and compressors are described and illustrated in 8-pp Bulletin SIF. It covers standard, silencer and ground level installation models in medium and large capacities, small capacity filters and breather filters. Gives complete data on specifications, sizes, weights and capacities. Dollinger Corp.

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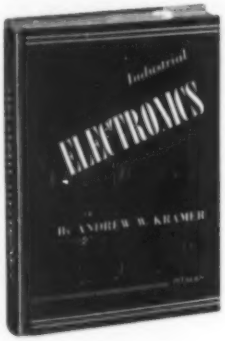

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267 Transmission Belting — Catalog M-9922, 28 pp, gives detailed design, engineering and performance data on manufacturer's line of transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included in the manual, together with hints on proper selection of a belt and procedure for analyzing belt drives. Illustrations include many photos of belt installations and drawings showing types of tranamission drives. United States Rubber Co.

268 Reference Bibliography for Water, Sewage and Power Plant Engineering—This 38 page, paper bound bulletin consists of a comprehensive and up-to-date listing of the best available sources of information on use of water for drinking and also for boiler feedwater supply; on sewage treatment and industrial waste treatment; and on power plant design and operation. The bibliography lists first a number of books and magazines covering water supply, treatment, treatment plant design and operation. Next, publications on the bacteriology of water and sewage. Third, publications covering sewage and industrial waste treatment and chemistry and analysis of water and sewage. Fourth, publications on power station design, operation and equipment and finally standard engineering handbooks, data and aid for hydraulic and power engineering. A list of foreign publications is also given. Also a list of periodicals on chemical laboratory procedure, water and sewage, and a good list of manufacturers publications. Published by Gilbert Associates, Inc.

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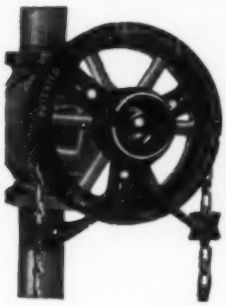

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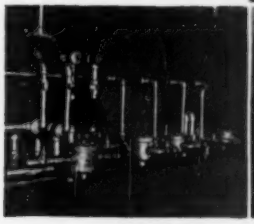

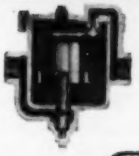

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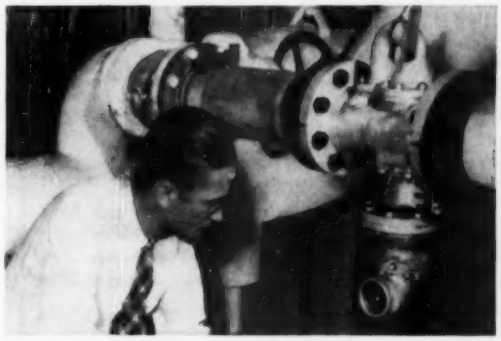

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(Continued from page 86)

of a color indicator which is described as both easy and accurate. Instructions for running the test are illustrated in color. Includes prices of company's complete hardness titration set and individual solutions used. W. H. & L. D. Betz.

134 In Case of Fire — This two-color chart is worth its size in wall space and deserves to be studied at leisure; but it's clear enough to be helpful in an emergency because it shows exactly which extinguisher to use and how to use it. Illustrates company's CO_2, dry chemical, foam, water, and vaporizing liquid extinguishers and, in tabular form, gives their applications, methods of operation, extinguishing effect, capacities and maintenance. Class A, B and C fires are defined and the effectiveness or limitations of each type of extinguisher on each class of fire can be noted at a glance. Walter Kidde & Co., Inc.

135 Industrial Clamp — Bulletin 310-IC, 4 pp, titled "Reg'ator Clamps for Industry," discusses the principles, characteristics and applications for these new clamps (see Page 48, POWER GENERATION, September, 1949). The first two sections, illustrated by engineering drawings, cover the clamps' automatic take-up, extendability, flexibility, constant pressure, coil form heads and long life. The section on applications is composed of photographs showing clamps in use in office and plant. Includes price list for standard stock sizes selected according to ASA recommendations. Hunter Spring Co.

136 Worm Gear Speed Reducers—Catalog 45-S, 24 pp, covers company's line of reducers made with horizontal worm at bottom, worm at top, or vertical drive available in 24 sizes, in ratio ranges of 5.66:1 to 100:1. Provides general specifications, rating tables and dimensions on these speed reducers and also on small double worm gear reducers for large ratios. Illustrated by photos of models and installations, dimensional drawings. D. O. James Gear Mfg. Co.

137 Lubricant Application Guide — Included in 30-pp Form C10L covering company's lubricants are tested recommendations for lubricating all types of bearings under various operating conditions. Other information covers lubrication of power generating, transmission and materials handling equipment, also special recommendations on the lubrication of pump glands, valves and other equipment subject to contact with acids, alkalis and moisture. A highly useful book, it's illustrated and indexed and arranged for easy reference. Contains list of suppliers by cities. Keystone Lubricating Co.

138 How Fiberglas Products Are Tested —This is a 36-pp publication describing the facilities and procedures employed in manufacturer's testing laboratories to provide customers with accurate data on the properties, uses and performance characteristics of Fiberglas materials in their various forms. Illustrated with numerous photos showing laboratory personnel operating testing facilities. Owens-Corning Fiberglas Corp.

139 Bearings and Castings — Illustrated with pictures and charts, this 28-pp booklet gives physical properties and comparative specifications for 27 different bronze alloys and five aluminum and manganese bronzes. It contains an outline of the many applications of bronze. Sizes and weights of rough and machined "Tiger" bronze bars are tabulated. Babbitt metals, their descriptions and uses, are also discussed and illustrated and their physical properties charted. Booklet also describes company's facilities for manufacture of non-ferrous bearings and castings. National Bearing Div., American Brake Shoe Co.

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The electrical engineering laboratories of educational institutions will find the amplistat useful for experiments in voltage or current regulation of small generators, investigation of motor speed control, totalizing and recording on one instrument the current in several independent circuits, demonstrating the principle of the amplistat, or for demostrating the principle of d-c current transformers and saturable reactors.

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PG 1-50

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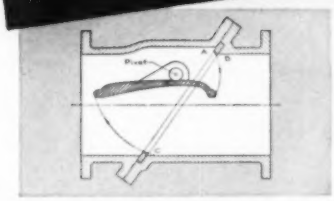


Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

That's right! With Chapman Tilting-Disc Valves, head losses are 65% to 80% lower than for conventional type check valves.

But no wonder head losses are lower. Chapman Check Valves work with . . . not against . . . the stream. The balanced disc rides smoothly on the flow . . . lifts away easily in opening and closes quickly and quietly. There's no slamming to cause destructive pipe line stresses . . . minimum wear on seats, hinge pins and bearings.

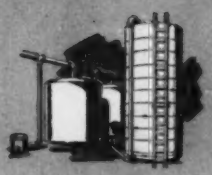
All these features mean lower maintenance costs for you. So write *today* for additional information.

The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS

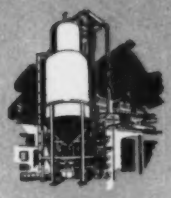
five basic power plant processes...

ZEO-KARB SOFTENER The Permutit Zeo-Karb® Softener removes both hardness and bicarbonates from raw water. The effluent is soft and reduced in total solids and alkalinity. The sulphate-carbonate ratio may be adjusted as desired by a system of mixed effluents.

SILICA REMOVAL PLUS DEMINERALIZATION Demineralization by cold ion exchange processes produces water of comparable quality to distilled water at a small fraction of the cost of distillation. Treatment by an anion exchange resin, Permutit S,® reduces silica to less than 0.5 ppm.



DEAERATING HEATER The Permutit Deaerating Heater, utilizing exhaust or bled steam, prevents corrosion of feed lines, stage heaters, economizers, and boilers by removing *all* oxygen and free CO_2. Capacities from 12,500 to 1,400,000 pounds per hour are in service.



SLUDGE BLANKET HOT LIME SODA The application of the sludge blanket design to hot lime soda treatment gives you soft water of a low silica content. Lower turbidity eases the load on the filters... savings in operating costs are substantial.

PRECIPITATOR The Permutit Precipitator is used to lower alkalinity, reduce hardness, and help to remove turbidity. It can also be used to reduce silica.

Consult Permutit without obligation on any of these processes. Our know-how in water conditioning, backed by 35 years experience, can provide the answer to any water treatment problem. Write to The Permutit Company, Dept. PG-1, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., Montreal.

Permutit

Water Conditioning Headquarters For Over 35 Years